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NATIONAL DAM SAFETY PROGRAM. LEADWOOD TAILINGS DAM (MO 30274), --ETC(U)
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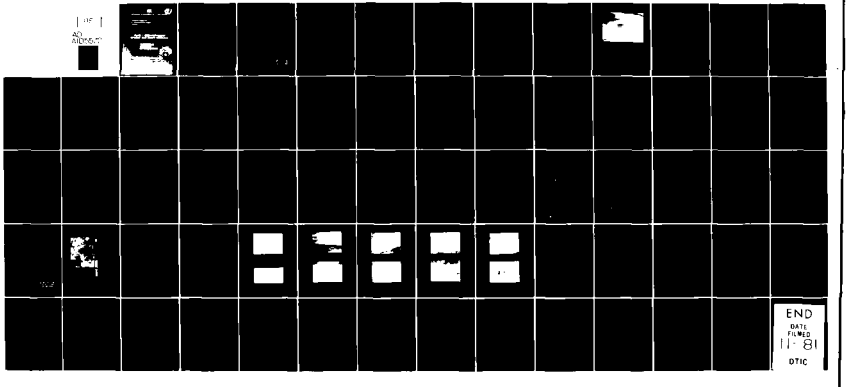

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Leadwood Tailings Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Leadwood Tailings Dam (MO 30274).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 6 JUL 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 7 JUL 1981
Colonel, CE, Commanding — Date

LEADWOOD TAILINGS DAM

St Francois County, Missouri

Missouri Inventory No. 30274

Phase I Inspection Report

National Dam Safety Program

Prepared by

Woodward-Clyde Consultants

Chicago, Illinois

Under Direction of

St Louis District, Corps of Engineers

for

Governor of Missouri

April 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Leadwood Tailings Dam
State Located	Missouri
County Located	St. Francois
Stream	Eaton Branch
Date of Inspection	22 October 1980

Leadwood Tailings Dam, Missouri Inventory Number 30274, was inspected by Richard Berggreen (engineering geologist), Leonard Krazynski (geotechnical engineer), and Sean Tseng (hydrologist). The dam is an abandoned lead tailings dam.

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, US Army, Washington, DC, with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines represent a consensus of the engineering profession. They are intended to provide for an expeditious identification based on available data and a visual inspection of those dams which might pose hazards to human life or property. In view of the limited nature of the study, no assurance can be given that all deficiencies have been identified.

The St Louis District (SLD), Corps of Engineers, has classified this dam as having a high hazard potential. The damage zone length estimated by the SLD extends approximately five miles downstream of the dam. Within the first one mile are at least four occupied homes and Missouri State Highway 8. Flood flows will enter the drainage for the Big River about 3/4 mile downstream.

Leadwood Tailings Dam is in the intermediate size classification based on its maximum height of 60 ft. Its reservoir water storage volume is about 230 ac-ft. The intermediate dam classification includes dams between 40 and 100 ft in height, or having storage capacities between 1000 and 50,000 ac-ft.

Our inspection and evaluation indicate the dam and appurtenant structures are in generally fair condition. Deficiencies noted include the potential for overtopping of the embankment for flood flows greater than 18 percent of the Probable Maximum Flood and the lack of seepage and stability analyses as per the "Recommended Guidelines for Safety Inspection of Dams."

The slopes of the embankment are quite flat (approximately 5 horizontal to 1 vertical). No evidence was noted of slope instability such as cracking, slumping or displacement of the vertical or horizontal alignment of the dam crest. No animal burrows, sinkhole development, or detrimental settlement was noted. No seepage was noted, but water flowing from the decant outlet could have masked small amounts of seepage. A deep gully had been eroded at the junction of the embankment and right abutment. No evidence or record of overtopping was noted during the visual inspection.

Our hydraulic/hydrologic analyses indicate the decant system and spillway will pass the 1 percent probability-of-occurrence flood without overtopping the dam. The 1 percent flood is the flood event that has a 1 percent probability of occurring in any one year, or occurs on the average once every 100 years. These analyses also indicate the dam will be overtopped by a flood that produces greater than 18 percent of the Probable Maximum Flood (PMF). The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible for the region. The recommended spillway design flood for intermediate size dams is 100 percent of the PMF. The embankment is composed of medium to fine sand and is judged to be extremely susceptible to erosion by flowing water. Overtopping for any significant duration or depth would likely lead to an effective breach of the dam. It should be noted that for flood events of greater than 18 percent of the PMF, the analysis included a hypothetical breach of Eaton Dam (MO 31163) which is located immediately upstream of the Leadwood reservoir.

Based on our inspection and evaluation of available information, the following specific recommendations are made for this dam. Action should be taken on these recommendations without undue delay.

1. Hydraulic and hydrologic analyses of Leadwood Tailings Dam should be made, taking into consideration the remedial measures adopted by the same owner for Eaton Dam located immediately upstream. The guidelines require intermediate size dams to pass a spillway design flood of 100 percent of the PMF without overtopping the embankment. Leadwood Tailings Dam spillway and storage capacities should be designed to accommodate the maximum indicated outflow from Eaton Dam without overtopping. Both dam embankments are highly susceptible to erosion by flowing water. The likelihood of failure in the event of significant overtopping is considered high.

2. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should be made for appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of tailings dams.

3. The feasibility of a practical warning system should be evaluated to alert downstream residents and traffic in the event hazardous conditions develop at this dam.

It is also recommended that a program of periodic inspections and maintenance be developed for this dam and appurtenant structures. This program should include but not be limited to the following items.

1. Monitor the embankment for evidence of slope instability such as cracking, slumping, or settlement of the dam crest.

2. Repair erosion gullies along the junction of the embankment and right abutment (or at other locations, as needed).

3. Maintain the spillway, discharge channel, and decant tower inlet free of debris which could lead to reduced discharge capacity.

All remedial measures and maintenance should be performed by or under the guidance of an engineer experienced in the design, construction, and maintenance of tailings dams.

It is recommended the owner take action on these remedial measures and maintenance without undue delay, in order to preclude development of hazardous conditions.

WOODWARD-CLYDE CONSULTANTS

Richard G. Berggreen
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Vice President

OVERVIEW

LEADWOOD TAILINGS DAM

MISSOURI INVENTORY NUMBER 30274

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LEADWOOD TAILINGS DAM, MISSOURI INVENTORY NO. 30274
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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LEADWOOD TAILINGS DAM, MISSOURI INVENTORY NO. 30274

SECTION 1
PROJECT INFORMATION

1.1 General

a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of Leadwood Tailings Dam, Missouri Inventory Number 30274.

b. **Purpose of inspection.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").

c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams," and Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "Engineering and Design National Program for Inspection of Non-Federal Dams" prepared by the Office of Chief of Engineers, Department of the Army; and "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams," prepared by the St Louis District (SLD), Corps of Engineers. These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

a. **Description of dam and appurtenances.** Leadwood Tailing Dam is an abandoned lead tailings dam. Although its construction and usage are typical of other lead tailings dams in the area, it is atypical of dams constructed for the impoundment of water. The unique nature of these lead tailings dams has a significant impact on their evaluation. A brief description of their construction and usage is necessary to distinguish the differences between these dams and conventional water-retaining dams.

The lead tailings dams in southeastern Missouri have been constructed over a long period of time and include dams ranging from very old dams constructed in the 1800's to active modern dams still under construction. Although the construction techniques have changed, these dams share many similarities.

At the beginning of a mining operation a starter dam is frequently constructed of waste rock and residual soil. This dam is used to impound surface runoff and mine water pumped from the underground workings. The water is used in the ore processing and transport of the tailings waste. The reservoir formed by the starter dam constitutes the initial tailings disposal area.

The tailings are the waste material produced by the beneficiation and processing of the lead ore to form a high grade lead concentrate. The coarse tailings fraction (medium to fine sand) is used to construct the dam embankment; the fine fraction, (silt and fine sand) is deposited in the reservoir area. Separation of the coarse and fine fractions usually is done at a cyclone separator or a series of cyclones on the crest of the dam. The underflow or coarse fraction is deposited on the dam and the overflow or fine fraction is pumped into the reservoir, where it settles.

The dams are typically constructed using the downstream method. That is, as the tailings are added to the dam, they are deposited on the crest and downstream face. As a result, the centerline of the dam crest migrates downstream as the dam is raised.

Frequently the dam has a drainage system built into the foundation to aid in lowering the phreatic surface (water table) within the embankment. Water enters the dam both at the crest from the cyclone deposited tailings and from

the upstream face where the dam is in contact with the reservoir. A clay blanket may be constructed on the upstream face to reduce this infiltration from the reservoir.

A decant or water disposal system is typically constructed beneath the dam. This decant system consists of a vertical tower or sloping structure within the reservoir which decants or draws water from the surface of the reservoir where the water contains the least sediment. This water is then carried beneath the dam and exits downstream of the toe of the dam. From there it may be recycled or released to the natural stream drainage. The intake level of the decant tower or structure is regulated as the tailings and reservoir level rises to maintain a balanced system of inflow and outflow. The decant system also serves as discharge in the event of heavy precipitation, which is generally additional to other spillway provisions.

Two characteristics are noteworthy regarding the tailings used in the construction of these dams. First, the very uniform grain size and lack of clay or other binder makes this material extremely susceptible to erosion by flowing water. It is unlikely that embankments composed of this material could survive overtopping without dam failure. Second, the finely ground limestone and dolomite tailings are almost barren of nutrients necessary to support vegetation. It is frequently necessary to import topsoil or fertilizer in order to successfully vegetate the dam embankment. This difficulty in vegetating the surface of the dam contributes to the potential for erosion of the dam.

The tailings impounded by the dam consolidate fairly rapidly and once consolidated, will stand in near-vertical slopes of considerable height. These tailings are subject to erosion, but not flow. It is anticipated, based on inspection of failed lead tailings dams, that only a relatively small amount of tailings would be lost by erosion through a breach.

Leadwood Tailings Dam is an abandoned lead tailings dam, nearly barren of vegetation, and composed of apparently very erodible medium to coarse sand. There is a decant tower in the reservoir area with the outlet near the toe of the maximum section. No evidence was noted of a subdrain system. The spillway section in the discharge channel consists of a concrete culvert beneath a bridge at the left abutment. No structures requiring operation are present at this facility.

b. **Location.** Leadwood Tailings Dam is located within the community of Leadwood, in the western part of the town, just south of Missouri Highway 8 (Fig 1). The dam is on Eaton Branch, in Section 4, T36N, R4E, on the USGS Flat River, Missouri 7.5-minute quadrangle map. Drainage confluence with the Big River is about 4000 ft downstream of the dam.

c. **Size classification.** The dam is classified intermediate size based on its height of approximately 60 ft. The water storage capacity is approximately 230 ac-ft. Under the definition in the "Recommended Guidelines for Safety Inspection of Dams", an intermediate size dam is between 40 and 100 ft in height, or has between 1000 and 50,000 ac-ft storage capacity.

d. **Hazard classification.** The St Louis District (SLD), Corps of Engineers, has classified this dam as having a high hazard potential; we concur with this classification. The SLD estimated damage zone length extends approximately five miles downstream of the dam. Within the first one mile are at least four occupied dwellings, a paved street and Missouri Highway 8 (see Overview Photo). Approximately 3/4 mile downstream, flood flows enter the flood plain of the Big River. The contents of the damage zone were verified by aerial reconnaissance. The potential for property damage and loss of life could be high in the event of dam failure.

e. **Ownership.** We understand the dam is owned by St Joe Lead Company, P.O. Box 500, Viburnum, Missouri, 65566. Correspondence should be sent to the attention of Mr Jack Krokroskia.

f. **Purpose of dam.** The dam was constructed to impound tailings produced in the milling and processing of lead ore mined in the vicinity. The dam has been inactive since about 1925.

g. **Design and construction history.** Information on the design and construction of Leadwood Tailings Dam was obtained from interviews with Mr John Kennedy of St Joe Lead. Mr Kennedy was not present during operations at the Leadwood Dam.

Mr Kennedy indicated operations at Leadwood were active from about 1905 to 1925. The dam was constructed by hauling coarse tailings, medium to coarse sand size, to the dam in trucks. The material was dumped and pushed by dozers to form the dam embankment. Compaction was apparently limited to the construction equipment traffic. Fine tailings (fine sand and silt) were pumped from the mill into the impoundment where they were deposited by sedimentation.

No other records were available on the design or construction.

h. **Normal operating procedures.** The dam is currently abandoned and there are no facilities requiring operation.

1.3 Pertinent Data

a. **Drainage area.** 0.5 mi^2 for Leadwood Dam, plus 2.7 mi^2 for Eaton Dam located immediately upstream.

b. **Discharge of damsite.**

Maximum known flood at damsite	Unknown
Warm water outlet at pool elevation	N/A (Not applicable)
Diversion tunnel low pool outlet at pool elevation	N/A
Diversion tunnel outlet at pool elevation	N/A
Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation	720 ft^3/sec
Total spillway capacity at maximum pool elevation	720 ft^3/sec

c. **Elevations. (ft above MSL)**

Top of dam	793.1 to 801.7
Maximum pool - design surcharge	N/A

Full flood control pool	N/A
Recreation pool	N/A
Spillway crest (gated)	N/A
Upstream portal invert diversion tunnel	N/A
Downstream portal invert diversion tunnel	N/A
Streambed at centerline of dam	Unknown
Maximum tailwater	Unknown
Toe of dam at maximum section	737.3

d. **Reservoir.**

Length of maximum pool	1800 ft
Length of recreation pool	N/A
Length of flood control pool	N/A

e. **Storage (acre-feet).**

Spillway crest	200 to 300 (Tailings only. Estimate complicated by construction of Eaton Dam on top of Leadwood Tailings.)
Flood control pool	N/A
Design surcharge	N/A
Top of dam	230 (water storage) (Tailings storage estimated at 200 to 300 ac-ft. Estimate complicated by construction of Eaton Dam on top of Leadwood tailings.)

f. **Reservoir surface (acres).**

Top of dam	51
Maximum pool	51
Flood control pool	N/A
Recreation pool	N/A
Spillway crest	29

g. **Dam.**

Type	Lead tailings dam

Length	1775 ft
Height	60 ft
Top width	25 ft (typical)
Side slopes	Upstream, unknown; Downstream, 4 or 5(H) to 1(V)
Zoning	Unknown, probably none
Impervious core	Unknown, probably none
Cutoff	Unknown, possibly clay-filled trench to shallow bedrock
Grout curtain	Unknown, probably none

h. **Diversion and regulating tunnel.**

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating facilities	N/A

i. **Spillway.**

Type	Rectangular concrete culvert under bridge, 7 ft tall, 6 ft wide
Length of weir	6 ft
Crest elevation	785.3 ft (see Fig. 3-B)
Gates	None
Downstream channel	Unlined channel, locally eroded to bedrock. Partially obstructed by dense vegetation.

j. **Regulating outlets.** Decant system. Inlet tower in reservoir, el 785.0 ft. Inflow capacity approximately 350 ft^3/sec; outlet culvert at toe of dam, 6 ft tall, 5 ft wide.

SECTION 2
ENGINEERING DATA

2.1 Design

No design drawings or records were found for this dam. Mr John Kennedy, of St Joe Lead, supplied the information on the construction history of the dam. Mr Kennedy was not present at the construction of the dam.

2.2 Construction

Construction of the dam was begun about 1905 and completed by about 1925. The site preparation prior to construction is not known. The embankment was constructed of coarse tailings (medium to coarse sand) hauled to the dam site in trucks and then flattened by pushing with dozers. Compaction was apparently limited to truck and dozer traffic. Fine-grained tailings were pumped into the impoundment from the processing plant located southeast of the dam.

No other records were available on the construction of this dam.

2.3 Operation

Leadwood Tailings Dam is abandoned at present and there are no operating records available. Water level in the reservoir is controlled by the decant tower and ungated spillway. No records are available on the history of flow through the decant outlet or the spillway. No record or evidence of overtopping was noted during the visual inspection.

2.4 Evaluation

a. **Availability.** The available data on engineering and construction are limited to interviews with Mr Kennedy. No records or design drawings were available.

b. **Adequacy.** The available information is insufficient to evaluate the design of Leadwood Tailings Dam.

Seepage and stability analyses comparable to the requirements of the guidelines are not on record. This is a deficiency that should be rectified. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. These analyses should be performed by a professional engineer experienced in the design and construction of tailings dams.

c. **Validity.** There is no reason to question the validity of the information obtained from Mr. Kennedy. It agreed with the observations made during the inspection. However, the information is incomplete.

2.5 Project Geology

The dam site is located just north of the center of the Ozark structural dome. Regional dip of the bedrock is toward the north but there is much local variation in dip around the buried and exposed Precambrian highlands.

The bedrock exposed in the vicinity of the dams is a flaggy to shaley dolomite. The area is mapped on the Geologic Map of Missouri (1979) as Cambrian age Elvins Group and Bonneterre Formation (Fig 4). The Elvins Group, consisting of the Davis Formation and Derby-Doerun Formation, is exposed at the surface and contains shale, siltstone, fine-grained sandstone, dolomite, and limestone conglomerate. The Bonneterre Formation, which occurs below the Elvins Group, is the host formation for the lead mineralization in this part of Missouri. The Bonneterre Formation is typically a gray, medium- to fine-grained dolomite, but mineralized zones may contain abundant granite and felsite debris eroded from the Precambrian basement complex.

The soil at the dam site is a slightly plastic, red-brown, gravelly to silty clay (CL). This soil is typical of the residual soils developed by the weathering of the carbonate bedrock in the area. The soil is mapped on the General Soils Map of Missouri (1979) as Peridge-Cantwell-Gasconade Soil Association.

The dam site is located near the north end of the Simms Mountain Fault System. The dam site is actually within the fault system which is about 5 miles wide and 40 miles long, in a northwest-southeast direction. Faults within the fault system typically show displacement up on the southwest side.

The faults in the immediate vicinity of the dam site are: the Schultz Fault, about 1.5 miles northeast of the dam, the Mitchell Fault, about 1 mile east of the dam, and the Irondale Fault, about 1 mile south of the dam. These faults are within the Paleozoic bedrock and are likely Paleozoic in age. The area is not considered seismically active and the faults are not considered to represent a probable source of strong earthquake events.

The dam is located about 100 miles north of the line of epicenters for the very large New Madrid Earthquakes, which occurred in 1811 and 1812. A recurrence of an earthquake of the magnitude of the New Madrid event could cause significant damage at the dam, but an assessment of this risk is beyond the scope of this Phase I investigation.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The Leadwood Tailings Dam was inspected 22 October 1980. Mr John Kennedy of St Joe Lead Co accompanied the inspection team throughout the inspection. This inspection indicated the dam embankment is in generally good condition.

b. Dam. The dam embankment is constructed of ground dolomite lead tailings (Photo 1), as described in Section 2.2. An unpaved road crosses the crest of the dam (Photo 2). The embankment material is light gray to tan, silty fine sand (SP). The embankment tailings are cohesionless and permeable, and appear subject to severe erosion if overtopped. No evidence or record of past overtopping was noted during the inspection.

No settlement, slumping, cracking, or development of sinkholes was identified during the inspection. The vertical alignment of the dam crest appears undisrupted. The horizontal alignment is irregular (Photo 2) but appears to be result of original construction procedures.

Some gullying erosion by surface runoff was noted in the downstream face of the dam. At the junction of downstream face of the dam with the right abutment (as the observed faces downstream), a gully has been eroded as much as 8 ft deep (Photo 3). There is no erosion control on the upstream face, but water at the time of the inspection was confined to a small (approximately 1 ac) grass-filled pond near the decant tower (Photo 9). Wave erosion of the upstream face is not anticipated to be significant as the decant tower maintains a low pond elevation most of the time. Mine rock, 1 to 6-in. diameter, has been used to construct a 2 ft high berm on the upstream side of the road on the dam crest (Photo 4). This berm appears to be for erosion control, preventing runoff from the dam crest roadway running down the downstream slope.

No seepage was noted during the visual inspection. The discharge channel flows along the toe of the dam from the spillway at the left abutment. This channel is densely vegetated (Photo 5) and inspection of some seepage may have been obscured. The decant outlet exits the dam near the toe of the left abutment and was flowing approximately 100 gal/min at the time of the visual inspection. Seepage in this area could have been masked by flow from the decant outlet.

The downstream face was barren of vegetation (Photo 6). No animal burrows were noted on the dam.

c. Appurtenant structures.

1. Spillway. The spillway consists of a rectangular concrete culvert beneath a bridge at the left abutment (Photo 7). The culvert is 7 ft in height, 6 ft wide, and passes beneath the road which runs along the dam crest.

The upstream channel is contained by natural ground and a soil and rock berm (Photo 8). This channel may be subject to some erosion but the flat gradient indicates erosion is not likely to be severe.

The downstream channel is eroded to bedrock in places, is heavily vegetated, and is not anticipated to be subject to significant erosion.

No flow was occurring through the spillway at the time of the inspection, but there was evidence that the spillway and discharge channel had carried flood flows in the past. There is approximately a 3 ft drop-off at the downstream end of the concrete culvert.

2. Decant tower and outlet. Lead tailings dams in this area typically have a decant structure consisting of an inlet tower in the reservoir area and an outlet below the downstream toe of the dam. This structure is used to draw off water from the reservoir after the tailings have settled out.

At the Leadwood Dam the inlet for the decant tower is in a pond within the reservoir (Photo 9) and was not accessible for inspection. The potential for

obstruction of the inlet could not be determined during the inspection. The inlet windows on the tower were described by St Joe Lead Co as having a total open area of 5 ft by 7 ft.

The outlet for the decant system consists of a 5 ft wide, 6 ft tall concrete culvert which exits the toe of the dam near the left abutment (Photo 10). At the time of the inspection this outlet was flowing about 1/4 ft^3/sec (100 gal/min).

d. Reservoir area. The reservoir is nearly filled with silty sand lead tailings consisting of ground dolomite. A small (1 ac) pond was situated near the decant inlet tower (see Overview Photo). The remainder of the reservoir was vegetated with scattered grass and weeds, but did not have standing water.

The upstream (south) end of the reservoir consists of the embankment for the Eaton Tailings Dam (MO 31163). The slope on this embankment is quite flat, on the order of 8(H) to 1(V), and appeared stable. The southeast corner of the reservoir has a tailings pile adjacent to the reservoir, with slopes as steep as 2(H) to 1(V). Small scale slumping may occur on these slopes but does not appear sufficient to pose a safety hazard to the Leadwood Dam. No evidence of landslides or unstable slopes was noted during the visual inspection.

e. Downstream channel. The discharge channel below the spillway flows along the toe of the dam at the left abutment to the toe of the maximum section where it joins the original stream bed. Dense vegetation is present in much of the channel and could obstruct flow during flooding. The channel has eroded to bedrock in several locations and no further significant erosional deepening is anticipated to result from flood flows. Some lateral erosion may occur and erode parts of the toe of the dam. However, the embankment slopes are quite flat (Fig. 3) and the potential erosion is not expected to significantly affect the slope stability of the dam.

3.2 Evaluation

The visual inspection indicated the dam embankment is in generally good condition. The silty fine to medium sand which comprises the embankment appears highly erodible in the event of overtopping. No evidence of disruption of the vertical

alignment was noted; the horizontal alignment had some irregularities, but these appeared to be the result of the original construction procedures. No evidence was noted of slumping, cracking, settlement or sinkhole development. Erosion was noted on the downstream face, and has resulted in a gully 8 ft deep along the junction of the embankment and right abutment. No seepage or animal burrows were noted.

The decant structure was flowing about 1/4 ft^3/sec (100 gal/min) at the time of the inspection. The potential for obstruction of the decant tower inlet could not be evaluated during the inspection as the inlet was inaccessible.

The spillway culvert and upstream channel appeared open and not subject to significant obstruction. The downstream channel is densely vegetated and could become obstructed during flooding.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The dam has been inactive for more than 50 years. No operating procedures currently exist at this facility.

4.2 Maintenance of Dam

The only maintenance apparent at the facility is maintenance of the roadway on the crest of the dam.

4.3 Maintenance of Operating Facilities

There are no facilities requiring mechanical operation at this dam.

4.4 Description of Any Warning System in Effect

The visual inspection did not identify any warning system in effect at this dam.

4.5 Evaluation

No plan was identified for periodic inspections or performance of maintenance on the dam. This is considered a deficiency.

The feasibility of a practical warning system should be evaluated to alert downstream residents and traffic should potentially hazardous conditions develop during periods of heavy precipitation.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. **Design data.** No hydraulic or hydrologic design data were available for evaluation of this dam and reservoir. Dimensions and elevations of the dam, spillway and appurtenant structures were surveyed 13 November 1980 by James F. McCaul and Associates, Consulting Engineers and Land Surveyors, Potosi, Missouri. This survey data was used to prepare Fig. 3A and 3B. Other relevant data were measured during the field inspection 22 October 1980, or estimated from topographic mapping. The maps used in the analysis were a pre-dam topographic map (1905) and the USGS Flat River, Missouri 7.5-minute quadrangle map (1958).

b. **Experience data.** No recorded rainfall, runoff, discharge, or pool stage historical data were found for this reservoir. No evidence or record of overtopping was noted during the visual inspection.

c. **Visual observations.**

1. Watershed. The watershed above Leadwood Dam consists of two sub-basins. The immediate basin for Leadwood Dam consists of woodlands and the communities of Leadwood and Frankclay. The reservoir for Leadwood Dam occupies approximately 20 percent of the 0.5 mi^2 area of this drainage sub-basin.

Upstream from Leadwood Dam and reservoir is the larger sub-basin for Eaton Dam. This basin consists of woodlands and the communities of Frankclay and Wortham. Runoff from this sub-basin flows first through the reservoir and spillway for Eaton Dam before entering the sub-basin for Leadwood Dam. Some time delay and considerable water storage will occur as a result of the flood routing through the Eaton facility. The sub-basin area for Eaton Dam is approximately 2.7 mi^2.

2. Reservoir. The reservoir and dam are best described by the maps and photographs enclosed herewith. The purpose of the impoundment is to store

lead tailings. The reservoir has been inactive since the mid-1920's, and is nearly filled with lead tailings.

3. Spillway. The spillway is located at the northwest end of the dam and consists of a rectangular concrete culvert beneath the bridge for the road along the crest of the dam. The upstream and downstream channels are unlined and roughly trapezoidal in shape. A dropoff at the downstream end of the culvert indicates that critical flow will occur at the culvert; however, the culvert will not act as the control section during lower flows.

The decant tower and outlet, as described in Section 3.1.c.2. of this report, also regulates the pond elevation at this dam.

d. Overtopping potential. One of the primary considerations in the evaluation of the Leadwood Tailings Dam is the assessment of the potential for overtopping and possible consequent failure by erosion of the embankment. The outlet facilities at this dam, the decant system and bridge spillway culvert, are concrete structures, and erosion due to high velocity discharge in these locations is not anticipated.

Hydrologic analysis of Leadwood Dam for all events were based on starting water surface elevations equal to the decant tower inlet elevation. In accordance with the guidelines, a multiple dam analysis was performed, including a hypothetical breach of the upstream Eaton Dam, to assess the impact of overtopping and failure of the upstream dam on the overtopping potential of Leadwood Dam. For the upstream dam (Eaton Dam) the starting water surface elevation was set at the spillway crest.

The "Recommended Guidelines for Safety Inspection of Dams" requires intermediate size dams to pass a spillway design flood of 100 percent of the PMF. The results of the multiple dam analysis indicate a flood of greater than approximately 18 percent of the Probable Maximum Flood (PMF) will overtop the Leadwood embankment.* The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

*For events greater than 18 percent of PMF, routing includes hypothetical breach of Eaton Dam upstream.

The analysis also indicates the two Leadwood Tailings Dam outlets will pass the 1 percent probability-of-occurrence flood (100-yr flood) without overtopping the embankment. The combined outflow capacity of the decant structure and spillway culvert at the reservoir elevation equal to the minimum top of dam elevation is approximately 720 ft^3/sec.

The following table presents the results of the analyses for various precipitation events, assuming no erosion of the dam crest or spillway.

Precipitation Event	Maximum Reservoir Elevation, ft, MSL	Maximum Depth of Overtopping, ft	Maximum Outflow, ft^3/sec	Duration of Overtopping, hrs
1% Probability	793.0	0.0	700	0.0
18% PMF	793.3	0.0	720	0.0
50% PMF*	797.0	3.9	11,000	8.5
100% PMF*	797.2	4.1	12,000	11.2

*includes hypothetical breach of Eaton Dam

It should be noted that the potential for erosion of the embankment in the event of overtopping indicates that events greater than 18 percent of the PMF will likely lead to an effective breach of the Leadwood Tailings Dam, assuming that the conditions at both Eaton Dam and Leadwood Tailings Dam remain unchanged. If a breach of Eaton Dam is assumed, there appears to be no practical opportunity to provide sufficient spillway capacity at Leadwood Tailings Dam to safely pass the resulting outflow of 12,000 ft^3/sec. Both dams are owned by St Joe Lead Co and it appears that a satisfactory solution in this case would require simultaneous evaluation of both facilities.

Input data and output summaries for the hydraulic and hydrologic analyses are presented in the attached Appendix B.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. **Visual observations.** The visual inspection of Leadwood Tailings Dam revealed no evidence of horizontal or vertical disruption of the dam crest alignment. Cracking, settlement, slope instability, or sinkhole development were not observed. Surface erosion has cut a gully up to 8 ft deep along the right abutment. No seepage was noted during the visual inspection.

b. **Design and construction data.** Information on the design and construction of Leadwood Tailings Dam was limited to interviews with Mr John Kennedy of St Joe Lead Co. No plans or records of the dam construction were available.

Construction procedures for the tailings dam consisted of hauling coarse tailings to the dam site in trucks. The material was pushed by dozers to form the embankment. No records are available regarding the compaction of the material. Compaction was likely limited to the truck and dozer construction traffic.

No records are available regarding the design of the dam, decant system or any drainage facility. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not on record, which is considered a deficiency.

c. **Operating records.** The dam is inactive at present and no records are maintained of water levels, available storage, or flood flows through the decant system or spillway.

d. **Post construction changes.** The lack of design and construction records precludes identification of post construction changes. The only apparent change is the construction of Eaton Dam (MO 31163) upstream from the Leadwood Dam.

e. **Seismic stability.** The dam is in Seismic Zone 2, to which the guidelines assign a moderate damage potential. Since no static stability analysis is available for review, the seismic stability cannot be evaluated.

The uniform sand and silt size tailings are likely quite susceptible to liquefaction where the tailings are saturated. No information is available on the location of phreatic surface within the tailings, but substantial deformation and possibly failure of the embankment could occur during a severe seismic event.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. **Safety.** Based on our inspection and analyses of the dam and appurtenant structures, the dam is judged to be in generally fair condition. The most serious deficiency noted is the potential for overtopping and consequent failure of the dam for flood events greater than 18 percent of the PMF.

The slopes of the dam showed no evidence of instability such as cracking or slumping. No evidence was noted of animal burrows, detrimental settlement or sinkhole development. No seepage was noted at the toe of the dam. The spillway and decant system are in good condition, are concrete lined and are not considered subject to erosion. However, the deep erosion gully in the embankment at the right abutment indicates a need for periodic inspection and remedial maintenance work.

Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not on record, which is considered a deficiency.

b. **Adequacy of information.** The visual inspection and information obtained from St Joe Lead Co. personnel provided sufficient information to support the conclusions presented in this Phase I report. Seepage and stability analyses as required by the guidelines were not on record. This is considered a deficiency which should be corrected.

c. **Urgency.** The deficiencies described in this report could affect the safety of the dam. Particular attention should be paid to the inadequate spillway capacity and secondarily to the erosion at the junction of the embankment and right abutment. Remedial measures should be initiated without undue delay.

d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspections of Dams", the subject investigation was a minimum study.

This study revealed that additional in-depth investigations are needed to complete assessment of the safety of the dam. Those investigations which should be performed without undue delay are described in Section 7.2b. It is our understanding from discussions with the St Louis District that any additional investigations are the responsibility of the owner.

7.2 Remedial Measures

a. **Alternatives.** There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are listed below.

1. Remove the dam, or breach it to prevent the storage of water.

2. Increase the height of dam and/or spillway size to pass 100 percent of the PMF without overtopping the dam.

3. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy.

4. Provide a highly reliable flood warning system (generally does not prevent damage but decreases the chances for loss of life).

b. **Recommendations.** Based on our inspection and evaluation of data for Leadwood Dam, it is recommended the following topics be evaluated without undue delay.

1. Hydraulic and hydrologic analyses of Leadwood Tailings Dam should be made, taking into consideration the remedial measures adopted by the same owner for Eaton Dam located immediately upstream. The guidelines require intermediate size dams to pass a spillway design flood of 100 percent of the PMF without overtopping the embankment. Leadwood Tailings Dam spillway and storage capacities should be designed to accommodate the maximum indicated outflow from Eaton Dam without overtopping. Both dam embankments are highly susceptible to erosion by flowing water. The likelihood of failure in the event of significant overtopping is considered high.

2. Seepage and stability comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" should be performed and made a matter of record. Such analyses should consider appropriate loading conditions, including seismic loads, and should be made by an engineer experienced in the design and construction of tailings dams.

3. The feasibility of a practical warning system should be evaluated to alert downstream residents and traffic in the event hazardous conditions develop at this dam.

c. **O & M procedures.** It is recommended that a program of periodic inspections and maintenance be developed for this dam and appurtenant structures. This program should include but not be limited to the following items.

1. Monitor the embankment for evidence of slope instability such as cracking or slumping, or settlement of the dam crest.

2. Repair erosion gullies along the junction of embankment and right abutment (or at other locations, as needed).

3. Maintain the spillway, discharge channel, and decant tower inlet free of debris which could lead to reduced discharge capacity.

All remedial measures and maintenance should be performed by or under the guidance of an engineer experienced in the design, construction, and maintenance of tailings dams.

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Department of the Army, Office of the Chief of Engineers, 1977, EC 1110-2-188, Engineering and Design National Program of Inspection of Non-Federal Dams.

Department of the Army, Office of the Chief of Engineers, 1979, ER 1110-2-106, Engineering and Design National Program of Inspection of Non-Federal Dams.

Hydrologic Engineering Center, US Army Corps of Engineers, 1978, Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations.

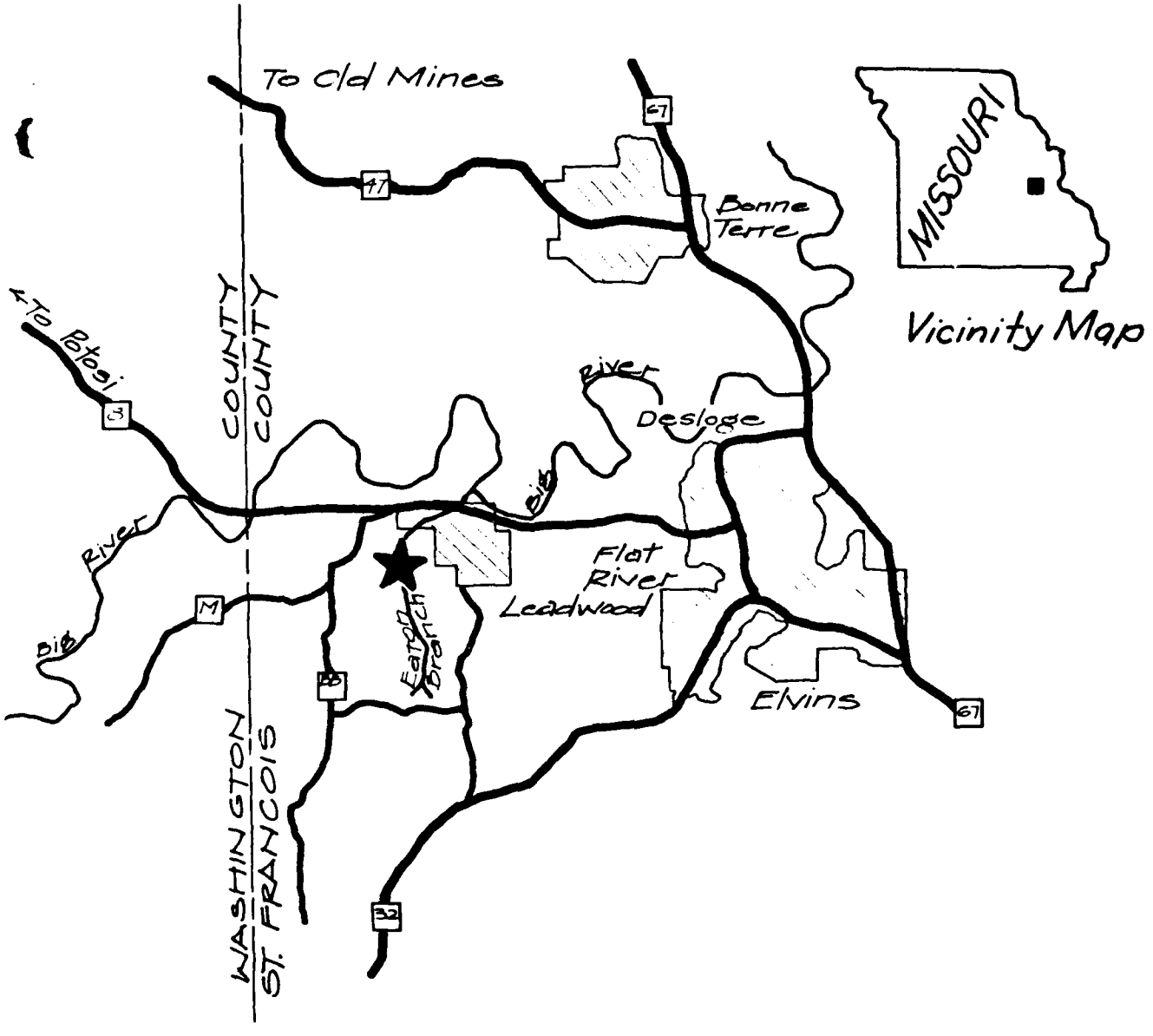
McCracken, M. H., 1971, Structural Features Map of Missouri: Missouri Geological Survey, scale 1:500,000.

Missouri Geological Survey, 1979, Geologic Map of Missouri: Missouri Geological Survey, scale 1:500,000.

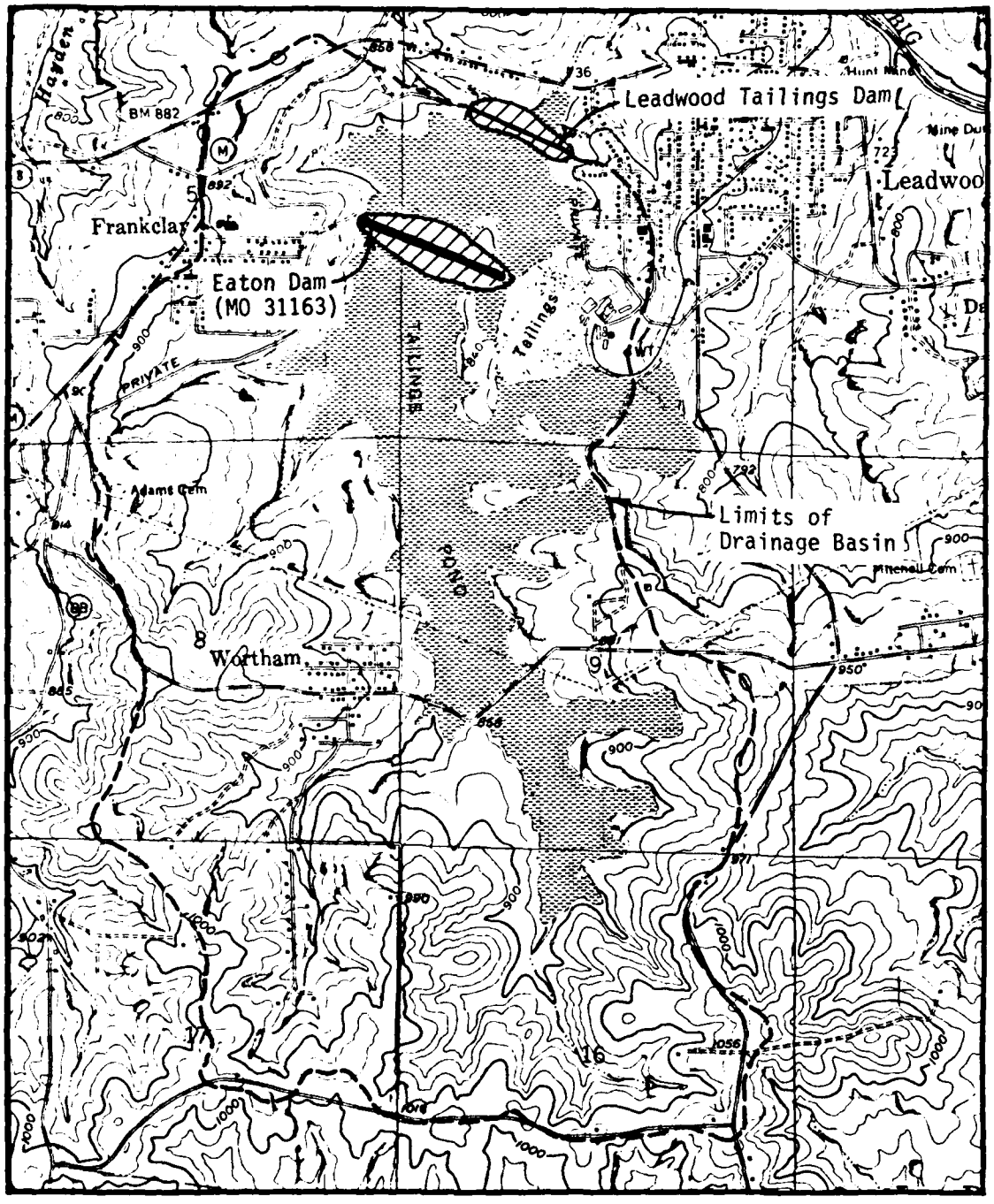
St Louis District, US Army Corps of Engineers, 1979, Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams.

US Department of Agriculture, Soil Conservation Service, 1971, Hydrology: National Engineering Handbook, Section 4.

US Department of Commerce, US Weather Bureau, 1956, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours, Hydrometeorological Report No. 33.



SITE LOCATION MAP	
LEADWOOD TAILINGS DAM	
MO 30274	Fig. 1



North

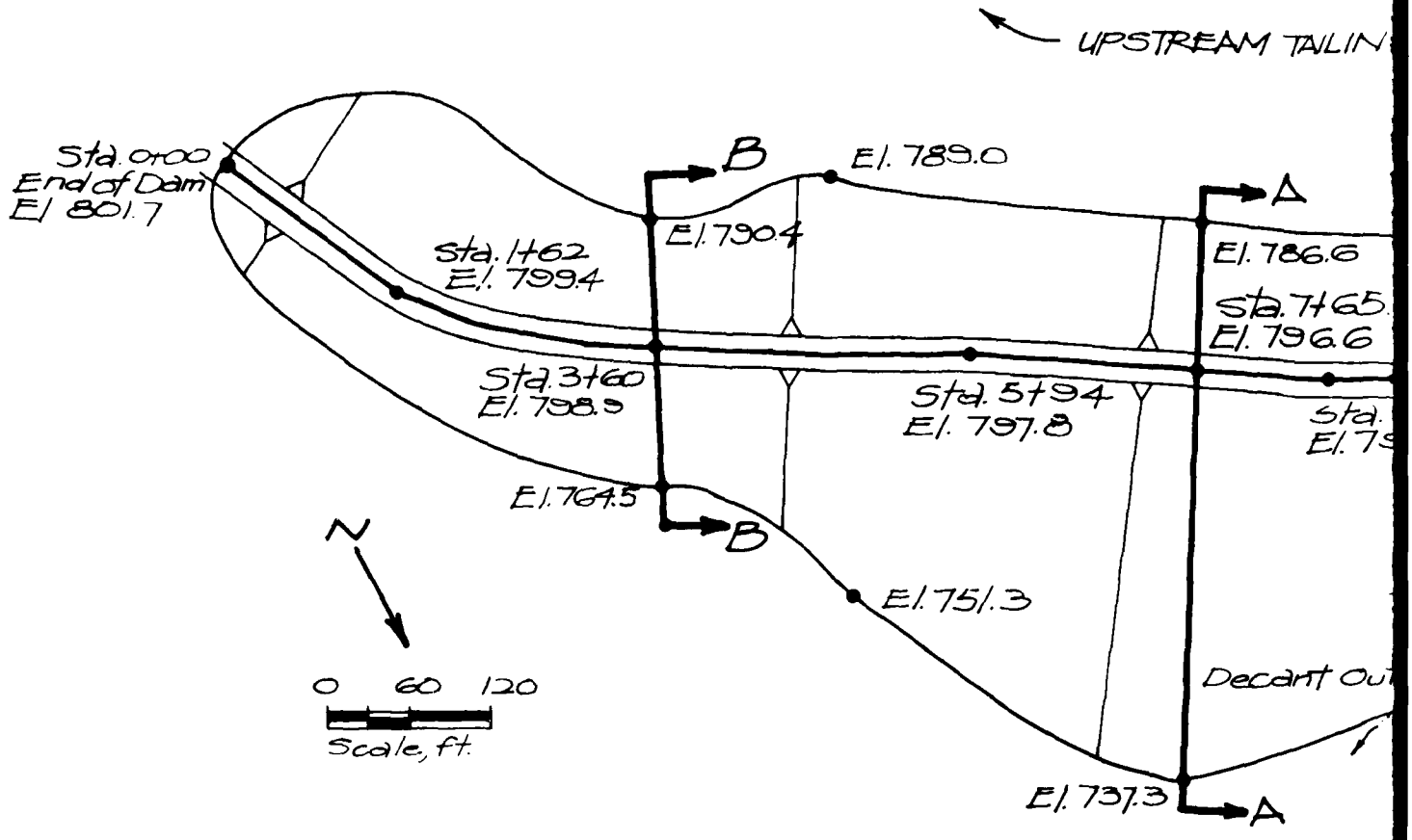
0 2000 4000

Scale, feet

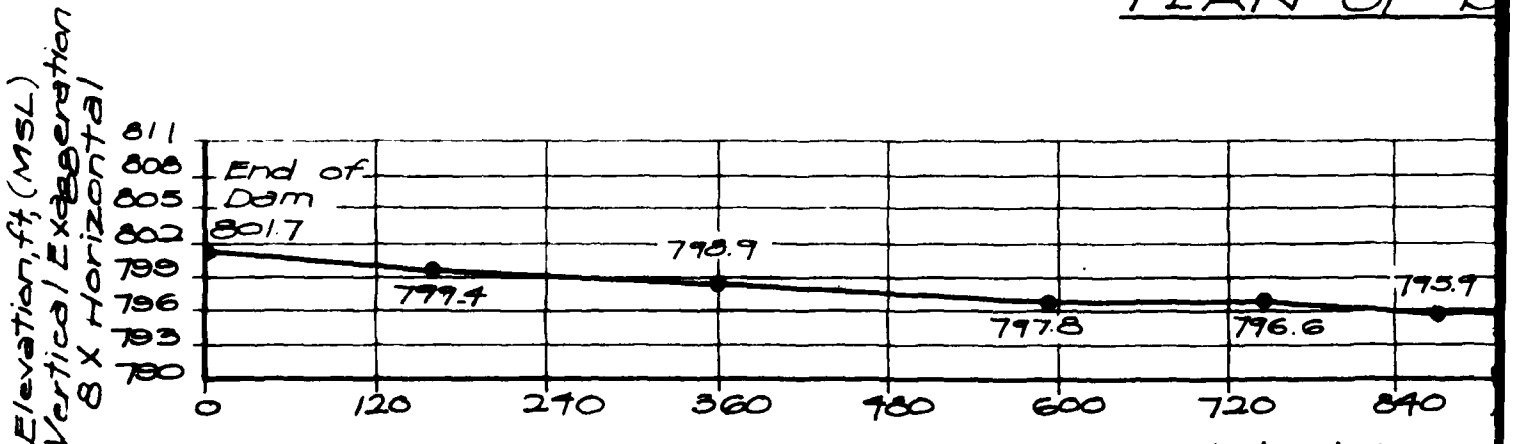
Notes:
1. Topography from USGS Flat River 7.5-minute quadrangle map (1958).
2. Tailings surface dry at time of inspection.

DRAINAGE BASIN AND SITE TOPOGRAPHY

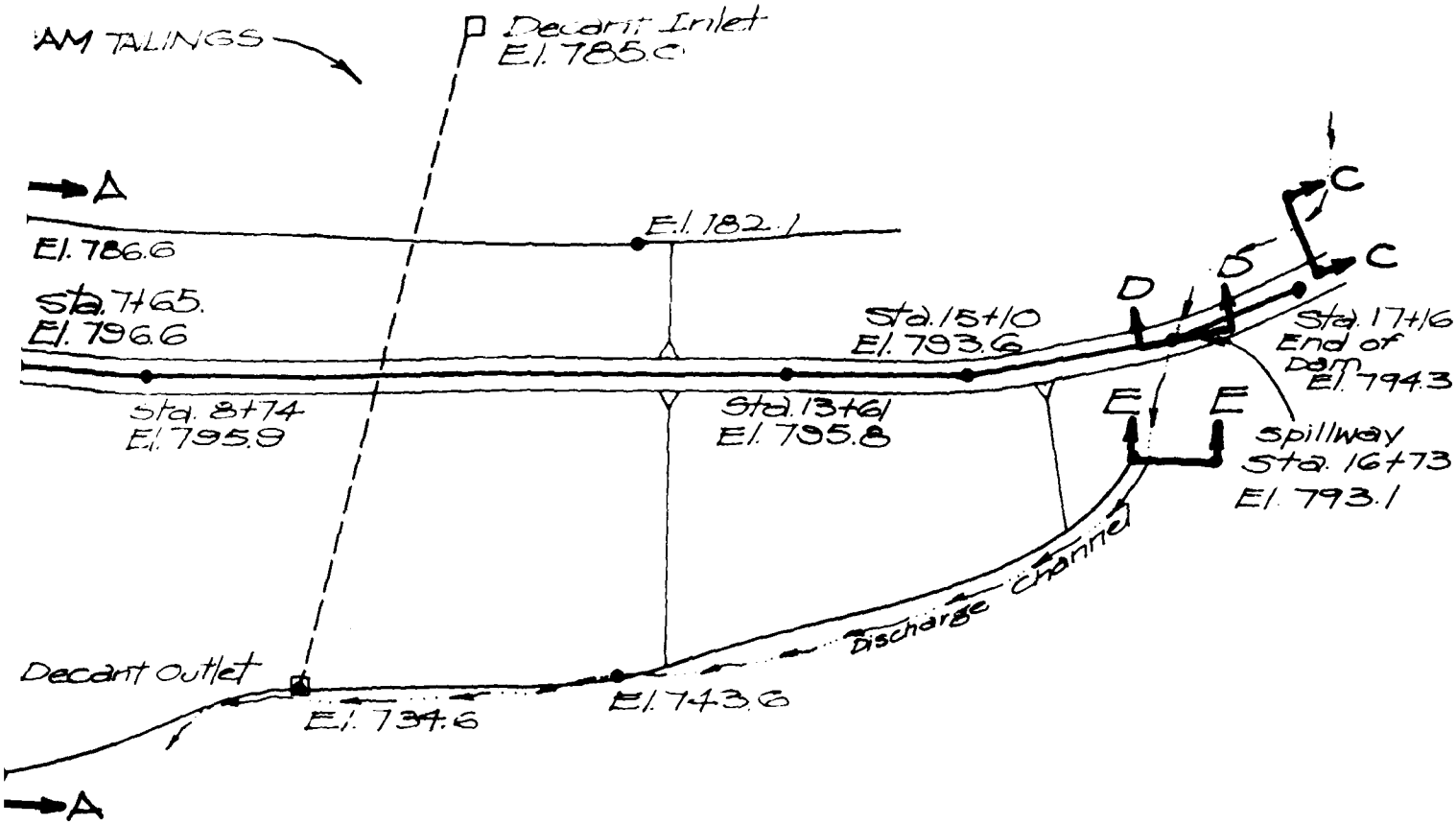
LEADWOOD TAILINGS DAM	
MO 30274	Fig. 2



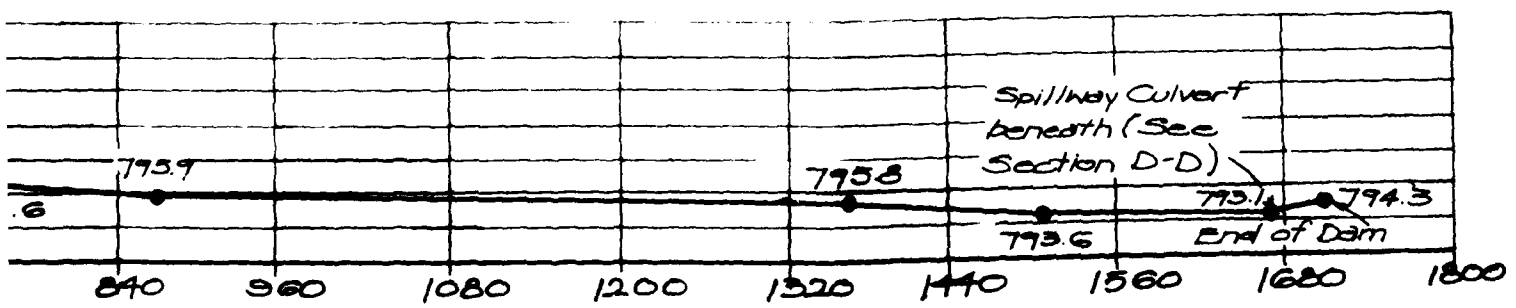
PLAN OF D



DAM PROFILE



J OF DAM



Distance, ft

ROFILE

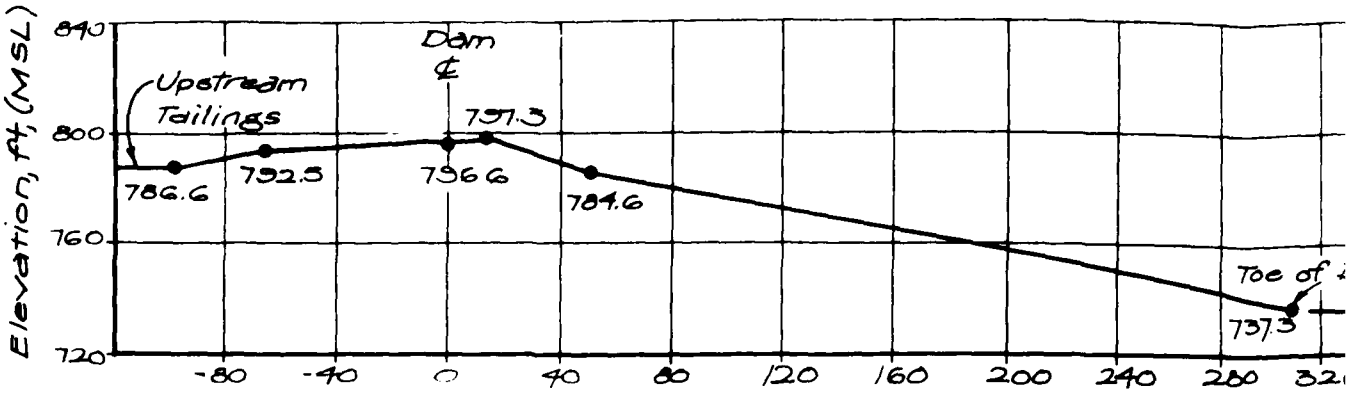
NOTE:
Surveyed 13 Nov. '80
by James F. McCaul, III
and Associates Consulting
Engineers/Land Surveyors
Potosi, Missouri

2

PLAN AND PROFILE OF DAM

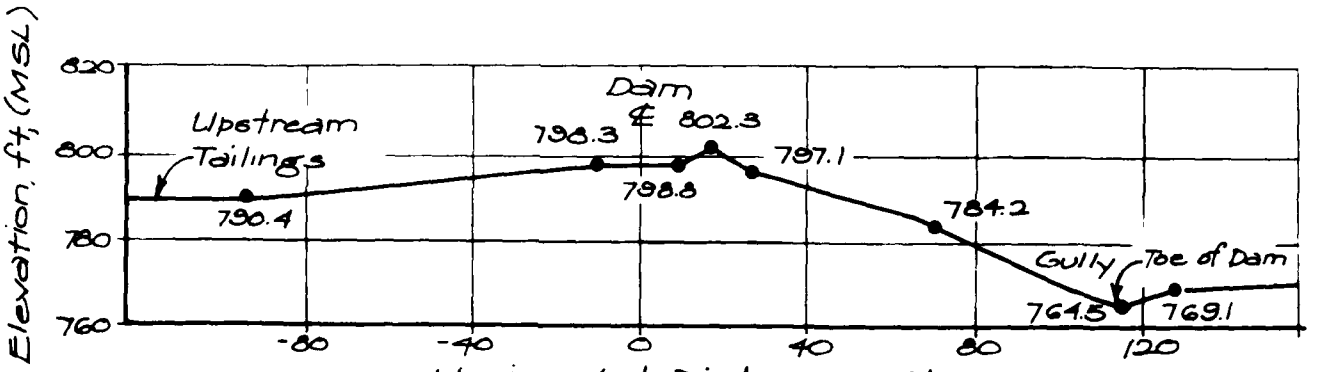
LEADWOOD TAILINGS DAM

MO 30274 | FIG. 3



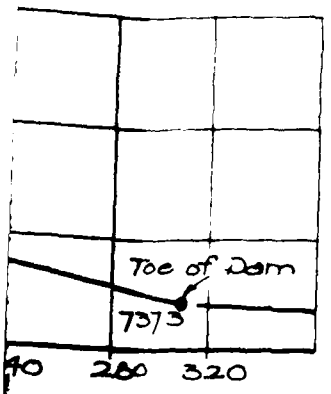
SECTION A-A

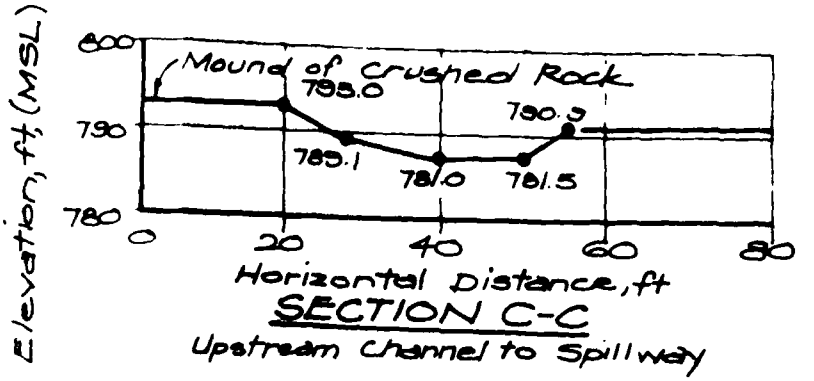
Maximum Dam Section



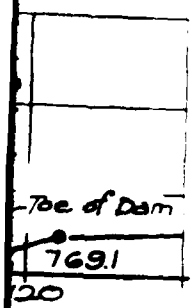
SECTION B-B

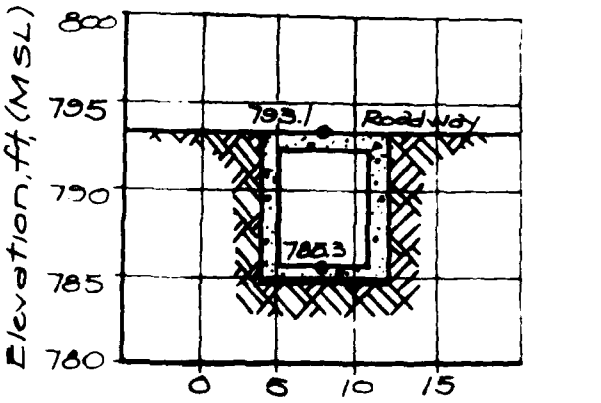
Dam Section



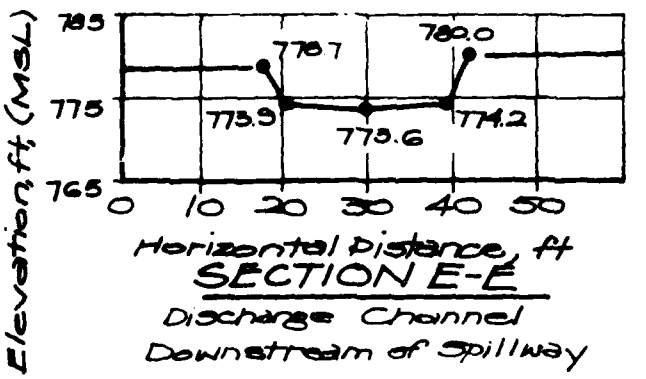


SECTION C-C
Upstream Channel to Spillway





SECTION D-D
Spillway (Bridge Culvert)



SECTION E-E
Discharge Channel
Downstream of Spillway

DAM, SPILLWAY, AND DISCHARGE CHANNEL CROSS SECTIONS

LEADWOOD TAILINGS DAM

MO 30274 | FIG. 3-B

Legend

- Or — Roubidoux Formation; Gasconade Dolomite; Gunter Sandstone Member
- Cep — Eminence Dolomite; Potosi Dolomite
- Derby-Doerun Dolomite
- Davis Formation
- Bonneterre Formation; Whetstone Creek Member; Sullivan Siltstone Member
- Reagan Sandstone (subsurface, western Missouri)
- Lamotte Sandstone
- Diabase (dikes and sills)
- St. Francois Mountains Intrusive Suite
- St. Francois Mountains Volcanic Supergroup

REGIONAL GEOLOGIC MAP

LEADWOOD TAILINGS DAM

MO 30274 | Fig. 4

APPENDIX A

Photographs

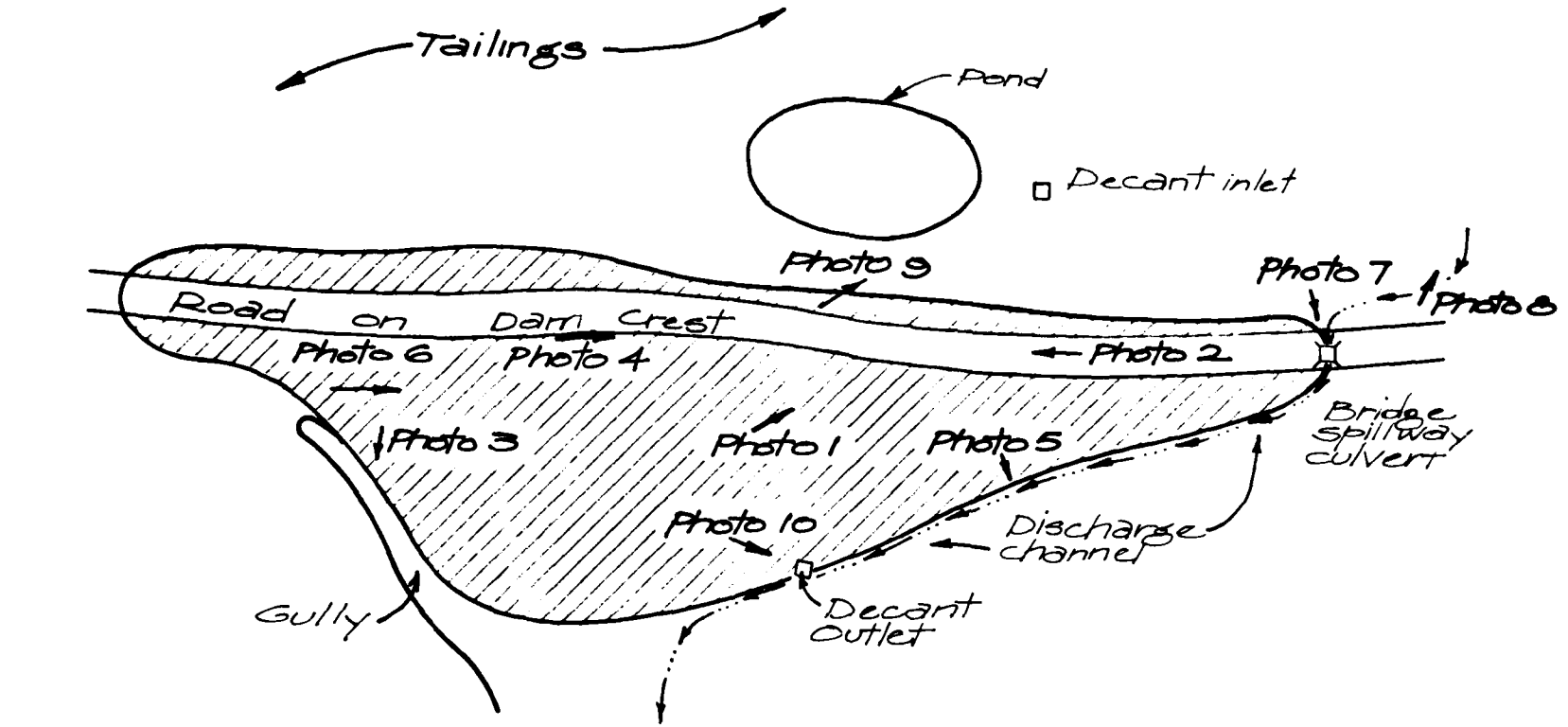
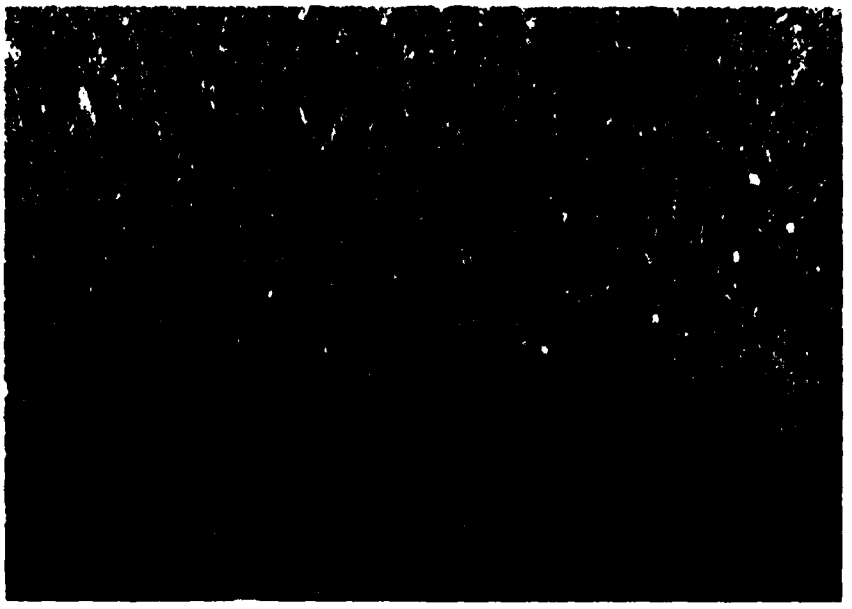


PHOTO LOCATION SKETCH

LEADWOOD TAILINGS DAM

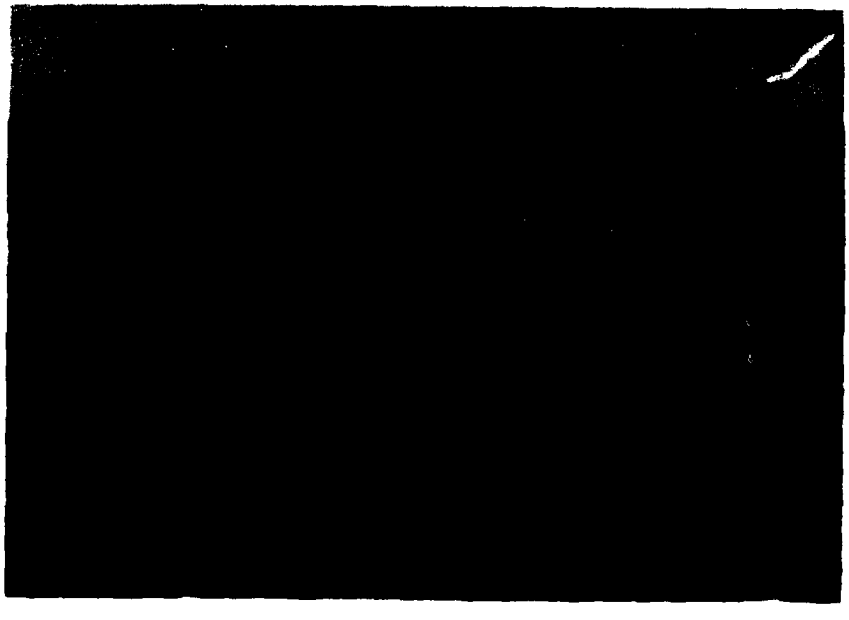
MO 30274 | Fig. A - 1



1. Ground dolomite tailings used to construct Leadwood Tailings Dam.

2. Roadway on crest of dam. Note irregular alignment of road. Probably due to original construction rather than deformation. Looking east-southeast.

3. Gully eroded at junction of embankment and right abutment. Looking north from crest of dam.



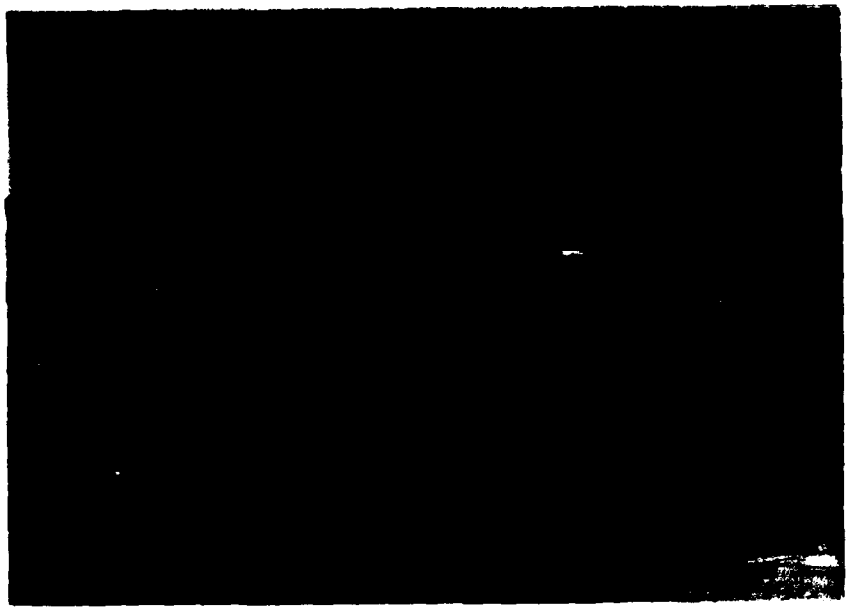
4. Mine rock berm on crest of dam to prevent surface runoff on crest of dam from flowing on the downstream face of dam. Looking west-northwest.

5. Vegetation congesting downstream channel. Note toe of dam in foreground of photo. Looking north.

6. Downstream slope of Leadwood Tailings Dam. Note lack of vegetation. Discharge channel at toe of dam in the distance. Looking west-northwest.

7. Spillway culvert beneath bridge at left abutment. Looking north. Culvert measures 7ft tall, 6ft wide.

8. Upstream channel above spillway. Natural ground to the right. Soil berm to the left. Reservoir out of picture to the left. Looking west, upstream in channel.



9. Decant tower inlet in reservoir. Looking southwest from crest of dam.

10. Decant system outlet at toe of dam. Note spillway discharge channel in background eroded to bedrock. Flow from decant outlet estimated at ¼ ft^3/sec (approx. 100 gpm). Looking northwest from toe of dam.

APPENDIX B

Hydraulic/Hyrologic Data and Analyses

APPENDIX B
Hydraulic/Hydrologic Data and Analyses

B.1 Procedures

a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.

b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District, Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956).

c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (SCS, 1971, Hydrology: National Engineering Handbook, Section 4) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi^2, and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{\ell^{0.8}\,(s+1)^{0.7}}{1900\,Y^{0.5}} \qquad \text{(Equation 15-4)}$$

where: L = lag in hours
ℓ = hydraulic length of the watershed in feet = 3500
$s = \frac{1000}{CN} - 10 = AMC\ II\ 3.333$
CN = hydrologic soil curve number as indicated in Section B.2e.
Y = average watershed land slope in percent = 5.3.

This empirical relationship accounts for the soil cover, average watershed slope and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_c = \frac{L}{0.6} \qquad \text{(Equation 15-3)}$$

where: T_c = time of concentration in hours

L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was approximated utilizing the following relationship:

$$\Delta D = 0.133 T_c \qquad \text{(Equation 16-12)}$$

where: ΔD = duration of unit excess rainfall
T_c = time of concentration in hours.

While the computed unit hydrograph duration was approximately 6 minutes, the final interval selected was 10 minutes. This interval was chosen as a compromise to account for the existence of an upstream dam (Eaton Mine Dam) which has a computed duration of over 15 minutes.

d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS curve number method. The curve numbers were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) vegetative cover and (d) present land usage in the watershed. In addition, the computed basin loss was reduced proportional to the impermeable area in the basin.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

(1) 1 and 10 percent probability events - decant inlet crest elevation of 785.0 ft.

(2) Probable Maximum Storm - decant inlet crest elevation of 785.0 ft.

Because the low level outlet structure is quite large, it was considered to be an integral part of this dam's overall capacity to pass floods.

f. Rating Curve. The HEC-2 computer program was used to compute the spillway rating curve using conveyance characteristics and cross sections for the spillway culvert and the decant outlet system.

B.2 Pertinent Data

a. Drainage area. 0.5 mi^2 for Leadwood Dam drainage basin, plus 2.7 mi^2 for Eaton Dam drainage basin.

b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 48 hours duration was divided into 10 minute intervals in order to develop the inflow hydrograph.

c. Lag time. 0.44 hrs.

d. Hydrologic soil group. C

e. SCS curve numbers. 1. For PMF- AMC III - Curve Number 88;
2. For 1 and 10 percent probability-of-occurrence events - AMC II -Curve Number 75

f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Flat River 7.5-minute quadrangle map. The data were entered on the $A and $E cards so that the HEC-1 program could compute the available water storage volumes.

g. Outflow over dam crest. As the profile of the dam crest is irregular, flow over the crest was computed according to the "Flow Over Non-Level Dam Crest" supplement to the HEC-1 User's Manual. The crest length-elevation data and hydraulic constants were entered on the $D, $L, and $V cards.

h. Outflow capacity. The rating curve of the decant outlet was computed by assuming weir flow prior to full orifice flow. This capacity was then combined with the spillway rating curve to derive a single outflow rating curve.

i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 785.0 ft, the decant tower inlet crest elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 785.0 ft, the elevation of the decant tower inlet crest.

B.3 Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the results summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

```
1  A1       EATON MINE DAM, NO. 31163, ST. FRANCOIS COUNTY, MISSOURI.
2  A2       WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224.
3  A3       PROBABLE MAXIMUM FLOODS.
4  B   288       0       10        0        0        0        0        0        0        0
5  B1    5
6  J      1       2        1
7  J1   .50    1.00
8  K      0    Q-IN1                                                    1
9  K1       EATON MINE INFLOW COMPUTATIONS, PMF.
10 M      1       2     2.70                              1.0
11 P      0      26      102      120      130      140
12 T                                                      -1      -88             0.10
13 W2            1.34
14 X     -1    -.05        5
15 K           DAM                                                      1
16 K1       FLOOD ROUTING AND OVERTOPPING ANALYSES
17 V                                          1        1
18 Y1    -1                                                   -827.3      -1
19 Y4 827.3   827.8   828.3   828.7   829.3   830.4   831.3   832.2   832.7   833.5
20 Y4 834.2   835.3   836.3
21 Y5    0.     10.     50.    100.    200.    500.    800.   1200.   1500.   2000.
22 Y5 2500.   3500.   4500.
23 S     0.      5.     30.     89.    190.    331.    410.    455.    672.   2708.
24 SE  770.    780.    790.    800.    810.    820.    825.    827.    830.    840.
25 SS 827.3
26 SD 831.8     2.7     1.5
27 SL    0.    175.    400.    425.    449.
28 SV 831.8    833.    834.    835.    836.
29 SB  10.0     0.5     603.     1.0   827.3   831.8
30 K     0    Q-IN2                                                    1
31 K1  LEADWOOD MINE DAM PMF INFLOW COMPUTATIONS.
32 M     1       2     0.50                              1.0
33 P     0      26      102      120      130      140
34 T                                                      -1      -88             0.20
35 W2            0.44
36 X    -1    -.05        5
37 K     2    Q-IN2
38 K     1     DAM2                                                    1
39 K1  LEADWOOD MINE TAILINGS DAM FLOOD ROUTING, PMF.
40 V                                          1        1
41 Y1    1                                                    -785.0      -1
42 Y4  785.   785.4   785.8   786.6   787.5   788.1    789.    790.    791.    792.
43 Y4  793.    794.    795.    796.    797.    798.    799.
44 Y5    0.     4.5    13.4    37.5    73.6    112.    190.    305.    470.    590.
45 Y5  700.    900.    930.    965.    990.   1020.   1045.
46 SA    0.      5.     30.    100.    125.    145.
47 SE  783.   785.3    790.    795.    800.    810.
48 SS 785.3
49 SD 793.1     2.8     1.5
50 SL    0.     90.    255.    325.    370.    615.    960.   1060.   1290.   1800.
51 SV 793.1   793.5    794.   794.5   794.9   795.5    796.    797.    798.    800.
52 K     99
```

No. 80C224
LEADWOOD

3-18-81 Version

PMF OUTPUT

Input Data
Various PMF Events
Leadwood Tailings Dam
MO 30274
B4

EATON MINE DAM, NO. 31163, ST. FRANCOIS COUNTY, MISSOURI.
WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224.
PROBABLE MAXIMUM FLOODS.

JOB SPECIFICATION

NQ	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	10	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1
RTIOS= .50 1.00

SUB-AREA RUNOFF COMPUTATION

EATON MINE INFLOW COMPUTATIONS, PMF.

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
Q-INI	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.70	0.00	2.70	1.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.00	102.00	120.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-88.00	0.00	.10

CURVE NO = -88.00 WETNESS = -1.00 EFFECT CN = 88.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.34

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 42 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.34 VOL= 1.00

38.	120.	230.	384.	579.	753.	862.	910.	910.	867.
795.	709.	598.	477.	385.	317.	261.	220.	183.	151.
124.	102.	85.	69.	58.	47.	39.	33.	27.	22.
18.	15.	13.	10.	9.	8.	6.	5.	4.	3.
2.	1.								

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	10	1	.00	.00	.00	1	1.03	10	145	.03	.03	.00	33

Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
B5

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.00	.00	.00	2.	1.02	.10	145	.03	.03	.00	32.
1.01	.20	2	.00	.00	.00	2.	1.02	.20	146	.03	.03	.00	34.
1.01	.30	3	.00	.00	.00	2.	1.02	.30	147	.03	.03	.00	36.
1.01	.40	4	.00	.00	.00	2.	1.02	.40	148	.03	.03	.00	38.
1.01	.50	5	.00	.00	.00	2.	1.02	.50	149	.03	.03	.00	41.
1.01	1.00	6	.00	.00	.00	1.	1.02	1.00	150	.03	.03	.00	43.
1.01	1.10	7	.00	.00	.00	2.	1.02	1.10	151	.03	.03	.00	45.
1.01	1.20	8	.00	.00	.00	2.	1.02	1.20	152	.03	.03	.00	110.
1.01	1.30	9	.00	.00	.00	2.	1.02	1.30	153	.03	.03	.00	139.
1.01	1.40	10	.00	.00	.00	2.	1.02	1.40	154	.03	.03	.00	168.
1.01	1.50	11	.00	.00	.00	2.	1.02	1.50	155	.03	.03	.00	176.
1.01	2.00	12	.00	.00	.00	2.	1.02	2.00	156	.03	.03	.00	192.
1.01	2.10	13	.00	.00	.00	2.	1.02	2.10	157	.03	.03	.00	209.
1.01	2.20	14	.00	.00	.00	2.	1.02	2.20	158	.03	.03	.00	218.
1.01	2.30	15	.00	.00	.00	2.	1.02	2.30	159	.03	.03	.00	227.
1.01	2.40	16	.00	.00	.00	2.	1.02	2.40	160	.03	.03	.00	234.
1.01	2.50	17	.00	.00	.00	2.	1.02	2.50	161	.03	.03	.00	240.
1.01	3.00	18	.00	.00	.00	2.	1.02	3.00	162	.03	.03	.00	246.
1.01	3.10	19	.00	.00	.00	2.	1.02	3.10	163	.03	.03	.00	250.
1.01	3.20	20	.00	.00	.00	2.	1.02	3.20	164	.03	.03	.00	254.
1.01	3.30	21	.00	.00	.00	2.	1.02	3.30	165	.03	.03	.00	257.
1.01	3.40	22	.00	.00	.00	2.	1.02	3.40	166	.03	.03	.00	260.
1.01	3.50	23	.00	.00	.00	2.	1.02	3.50	167	.03	.03	.00	262.
1.01	4.00	24	.00	.00	.00	2.	1.02	4.00	168	.03	.03	.00	264.
1.01	4.10	25	.00	.00	.00	2.	1.02	4.10	169	.03	.03	.00	266.
1.01	4.20	26	.00	.00	.00	2.	1.02	4.20	170	.03	.03	.00	267.
1.01	4.30	27	.00	.00	.00	2.	1.02	4.30	171	.03	.03	.00	269.
1.01	4.40	28	.00	.00	.00	2.	1.02	4.40	172	.03	.03	.00	270.
1.01	4.50	29	.00	.00	.00	2.	1.02	4.50	173	.03	.03	.00	271.
1.01	5.00	30	.00	.00	.00	2.	1.02	5.00	174	.03	.03	.00	272.
1.01	5.10	31	.00	.00	.00	2.	1.02	5.10	175	.03	.03	.00	273.
1.01	5.20	32	.00	.00	.00	2.	1.02	5.20	176	.03	.03	.00	273.
1.01	5.30	33	.00	.00	.00	2.	1.02	5.30	177	.03	.03	.00	274.
1.01	5.40	34	.00	.00	.00	2.	1.02	5.40	178	.03	.03	.00	274.
1.01	5.50	35	.00	.00	.00	2.	1.02	5.50	179	.03	.03	.00	275.
1.01	6.00	36	.00	.00	.00	2.	1.02	6.00	180	.03	.03	.00	275.
1.01	6.10	37	.01	.00	.01	2.	1.02	6.10	181	.13	.12	.01	288.
1.01	6.20	38	.01	.00	.01	2.	1.02	6.20	182	.13	.12	.01	291.
1.01	6.30	39	.01	.00	.01	3.	1.02	6.30	183	.13	.12	.01	313.
1.01	6.40	40	.01	.00	.01	3.	1.02	6.40	184	.13	.12	.01	350.
1.01	6.50	41	.01	.00	.01	3.	1.02	6.50	185	.13	.12	.01	405.
1.01	7.00	42	.01	.00	.01	4.	1.02	7.00	186	.13	.12	.01	476.
1.01	7.10	43	.01	.00	.01	5.	1.02	7.10	187	.13	.12	.01	550.
1.01	7.20	44	.01	.00	.01	5.	1.02	7.20	188	.13	.12	.01	644.
1.01	7.30	45	.01	.00	.01	6.	1.02	7.30	189	.13	.12	.01	739.
1.01	7.40	46	.01	.00	.01	7.	1.02	7.40	190	.13	.12	.01	816.
1.01	7.50	47	.01	.00	.01	7.	1.02	7.50	191	.13	.12	.01	859.
1.01	8.00	48	.01	.00	.01	8.	1.02	8.00	192	.13	.12	.01	902.
1.01	8.10	49	.01	.00	.01	8.	1.02	8.10	193	.13	.12	.01	1023.
1.01	8.20	50	.01	.00	.01	9.	1.02	8.20	194	.13	.12	.01	1069.
1.01	8.30	51	.01	.00	.01	9.	1.02	8.30	195	.13	.13	.00	1108.
1.01	8.40	52	.01	.00	.01	9.	1.02	8.40	196	.13	.13	.00	1140.
1.01	8.50	53	.01	.00	.01	9.	1.02	8.50	197	.13	.13	.00	1167.
1.01	9.00	54	.01	.00	.01	10.	1.02	9.00	198	.13	.13	.00	1191.

Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
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Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
B7

1.01	9.00	54	.01	.00	.01	10.	1.02	9.00	198	.13	.13	.00	1191.
1.01	9.10	55	.01	.00	.01	10.	1.02	9.10	199	.13	.13	.00	1211.
1.01	9.20	56	.01	.00	.01	10.	1.02	9.20	200	.13	.13	.00	1227.
1.01	9.30	57	.01	.00	.01	10.	1.02	9.30	201	.13	.13	.00	1241.
1.01	9.40	58	.01	.00	.01	10.	1.02	9.40	202	.13	.13	.00	1255.
1.01	9.50	59	.01	.00	.01	10.	1.02	9.50	203	.13	.13	.00	1264.
1.01	10.00	60	.01	.00	.01	10.	1.02	10.00	204	.13	.13	.00	1272.
1.01	10.10	61	.01	.00	.01	11.	1.02	10.10	205	.13	.13	.00	1280.
1.01	10.20	62	.01	.00	.01	11.	1.02	10.20	206	.13	.13	.00	1286.
1.01	10.30	63	.01	.00	.01	11.	1.02	10.30	207	.13	.13	.00	1292.
1.01	10.40	64	.01	.00	.01	12.	1.02	10.40	208	.13	.13	.00	1297.
1.01	10.50	65	.01	.00	.01	13.	1.02	10.50	209	.13	.13	.00	1303.
1.01	11.00	66	.01	.00	.01	13.	1.02	11.00	210	.13	.13	.00	1309.
1.01	11.10	67	.01	.00	.01	14.	1.02	11.10	211	.13	.13	.00	1308.
1.01	11.20	68	.01	.00	.01	15.	1.02	11.20	212	.13	.13	.00	1311.
1.01	11.30	69	.01	.00	.01	16.	1.02	11.30	213	.13	.13	.00	1314.
1.01	11.40	70	.01	.00	.01	17.	1.02	11.40	214	.13	.13	.00	1316.
1.01	11.50	71	.01	.00	.01	18.	1.02	11.50	215	.13	.13	.00	1318.
1.01	12.00	72	.01	.00	.01	19.	1.02	12.00	216	.13	.13	.00	1320.
1.01	12.10	73	.03	.01	.02	20.	1.02	12.10	217	.44	.43	.01	1339.
1.01	12.20	74	.03	.01	.02	22.	1.02	12.20	218	.44	.43	.01	1372.
1.01	12.30	75	.03	.01	.02	25.	1.02	12.30	219	.44	.44	.01	1444.
1.01	12.40	76	.03	.01	.02	29.	1.02	12.40	220	.44	.44	.01	1563.
1.01	12.50	77	.03	.01	.02	35.	1.02	12.50	221	.44	.44	.01	1742.
1.01	13.00	78	.03	.01	.02	43.	1.02	13.00	222	.44	.44	.01	1975.
1.01	13.10	79	.04	.02	.02	52.	1.02	13.10	223	.53	.52	.01	2244.
1.01	13.20	80	.04	.02	.02	63.	1.02	13.20	224	.53	.53	.01	2556.
1.01	13.30	81	.04	.02	.02	74.	1.02	13.30	225	.53	.53	.00	2898.
1.01	13.40	82	.04	.02	.02	87.	1.02	13.40	226	.53	.53	.00	3260.
1.01	13.50	83	.04	.02	.02	100.	1.02	13.50	227	.53	.53	.00	3638.
1.01	14.00	84	.04	.02	.02	114.	1.02	14.00	228	.53	.53	.00	3724.
1.01	14.10	85	.05	.03	.02	128.	1.02	14.10	229	.66	.66	.00	3992.
1.01	14.20	86	.05	.03	.02	142.	1.02	14.20	230	.66	.66	.00	4237.
1.01	14.30	87	.05	.03	.02	156.	1.02	14.30	231	.66	.66	.00	4469.
1.01	14.40	88	.05	.03	.02	171.	1.02	14.40	232	.66	.66	.00	4698.
1.01	14.50	89	.05	.03	.02	187.	1.02	14.50	233	.66	.66	.00	4925.
1.01	15.00	90	.05	.03	.02	204.	1.02	15.00	234	.66	.66	.00	5150.
1.01	15.10	91	.05	.03	.01	220.	1.02	15.10	235	.60	.60	.00	5361.
1.01	15.20	92	.08	.05	.02	237.	1.02	15.20	236	1.01	1.00	.00	5667.
1.01	15.30	93	.14	.10	.04	257.	1.02	15.30	237	1.81	1.81	.01	5861.
1.01	15.40	94	.35	.27	.08	288.	1.02	15.40	238	4.53	4.52	.01	6308.
1.01	15.50	95	.10	.08	.02	333.	1.02	15.50	239	1.31	1.31	.00	6972.
1.01	16.00	96	.06	.05	.01	390.	1.02	16.00	240	.91	.80	.00	7821.
1.01	16.10	97	.05	.04	.01	460.	1.02	16.10	241	.62	.62	.00	8899.
1.01	16.20	98	.05	.04	.01	536.	1.02	16.20	242	.62	.62	.00	10068.
1.01	16.30	99	.05	.04	.01	608.	1.02	16.30	243	.62	.62	.00	11114.
1.01	16.40	100	.05	.04	.01	657.	1.02	16.40	244	.62	.62	.00	11779.
1.01	16.50	101	.05	.04	.01	684.	1.02	16.50	245	.62	.62	.00	12075.
1.01	17.00	102	.05	.04	.01	693.	1.02	17.00	246	.62	.62	.00	12188.
1.01	17.10	103	.04	.03	.01	685.	1.02	17.10	247	.49	.49	.00	11999.
1.01	17.20	104	.04	.03	.01	666.	1.02	17.20	248	.49	.49	.00	11333.
1.01	17.30	105	.04	.03	.01	637.	1.02	17.30	249	.49	.49	.00	10741.
1.01	17.40	106	.04	.03	.01	600.	1.02	17.40	250	.49	.49	.00	10011.
1.01	17.50	107	.04	.03	.01	559.	1.02	17.50	251	.49	.49	.00	9239.
1.01	18.00	108	.04	.03	.00	524.	1.02	18.00	252	.49	.49	.00	8579.
1.01	18.10	109	.00	.00	.00	494.	1.02	18.10	253	.04	.04	.00	8027.
1.01	18.20	110	.00	.00	.00	466.	1.02	18.20	254	.04	.04	.00	7562.
1.01	18.30	111	.00	.00	.00	439.	1.02	18.30	255	.04	.04	.00	7117.
1.01	18.40	112	.00	.00	.00	409.	1.02	18.40	256	.04	.04	.00	6707.

1.01	17.30	105	.04	.03	.01	637.	1.02	17.30	249	.49	.49	.00	10741.
1.01	17.40	106	.04	.03	.01	600.	1.02	17.40	250	.49	.49	.00	10611.
1.01	17.50	107	.04	.03	.01	559.	1.02	17.50	251	.49	.49	.00	9239.
1.01	18.00	108	.04	.03	.00	524.	1.02	18.00	252	.49	.49	.00	8519.
1.01	18.10	109	.00	.00	.00	494.	1.02	18.10	253	.04	.04	.00	8087.
1.01	18.20	110	.00	.00	.00	466.	1.02	18.20	254	.04	.04	.00	7902.
1.01	18.30	111	.00	.00	.00	439.	1.02	18.30	255	.04	.04	.00	7087.
1.01	18.40	112	.00	.00	.00	409.	1.02	18.40	256	.04	.04	.00	6567.
1.01	18.50	113	.00	.00	.00	376.	1.02	18.50	257	.04	.04	.00	5949.
1.01	19.00	114	.00	.00	.00	340.	1.02	19.00	258	.04	.04	.00	5391.
1.01	19.10	115	.00	.00	.00	304.	1.02	19.10	259	.04	.04	.00	4797.
1.01	19.20	116	.00	.00	.00	268.	1.02	19.20	260	.04	.04	.00	4182.
1.01	19.30	117	.00	.00	.00	233.	1.02	19.30	261	.04	.04	.00	3634.
1.01	19.40	118	.00	.00	.00	201.	1.02	19.40	262	.04	.04	.00	3134.
1.01	19.50	119	.00	.00	.00	173.	1.02	19.50	263	.04	.04	.00	2684.
1.01	20.00	120	.00	.00	.00	148.	1.02	20.00	264	.04	.04	.00	2291.
1.01	20.10	121	.00	.00	.00	127.	1.02	20.10	265	.04	.04	.00	1981.
1.01	20.20	122	.00	.00	.00	110.	1.02	20.20	266	.04	.04	.00	1694.
1.01	20.30	123	.00	.00	.00	96.	1.02	20.30	267	.04	.04	.00	1479.
1.01	20.40	124	.00	.00	.00	85.	1.02	20.40	268	.04	.04	.00	1301.
1.01	20.50	125	.00	.00	.00	75.	1.02	20.50	269	.04	.04	.00	1159.
1.01	21.00	126	.00	.00	.00	67.	1.02	21.00	270	.04	.04	.00	1037.
1.01	21.10	127	.00	.00	.00	61.	1.02	21.10	271	.04	.04	.00	930.
1.01	21.20	128	.00	.00	.00	56.	1.02	21.20	272	.04	.04	.00	847.
1.01	21.30	129	.00	.00	.00	51.	1.02	21.30	273	.04	.04	.00	779.
1.01	21.40	130	.00	.00	.00	48.	1.02	21.40	274	.04	.04	.00	721.
1.01	21.50	131	.00	.00	.00	44.	1.02	21.50	275	.04	.04	.00	672.
1.01	22.00	132	.00	.00	.00	42.	1.02	22.00	276	.04	.04	.00	631.
1.01	22.10	133	.00	.00	.00	40.	1.02	22.10	277	.04	.04	.00	596.
1.01	22.20	134	.00	.00	.00	38.	1.02	22.20	278	.04	.04	.00	566.
1.01	22.30	135	.00	.00	.00	36.	1.02	22.30	279	.04	.04	.00	541.
1.01	22.40	136	.00	.00	.00	35.	1.02	22.40	280	.04	.04	.00	521.
1.01	22.50	137	.00	.00	.00	34.	1.02	22.50	281	.04	.04	.00	508.
1.01	23.00	138	.00	.00	.00	33.	1.02	23.00	282	.04	.04	.00	497.
1.01	23.10	139	.00	.00	.00	33.	1.02	23.10	283	.04	.04	.00	488.
1.01	23.20	140	.00	.00	.00	32.	1.02	23.20	284	.04	.04	.00	480.
1.01	23.30	141	.00	.00	.00	32.	1.02	23.30	285	.04	.04	.00	474.
1.01	23.40	142	.00	.00	.00	32.	1.02	23.40	286	.04	.04	.00	469.
1.01	23.50	143	.00	.00	.00	31.	1.02	23.50	287	.04	.04	.00	465.
1.02	0.00	144	.00	.00	.00	31.	1.03	0.00	288	.04	.04	.00	462.
									SUM	36.40	34.97	1.43	360872.
										(925.1(	888.1(	36.1(	10218.7(

Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
B8

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	12075.	7121.	2392.	1252.	360652.
CMS	342.	202.	68.	35.	10213.
INCHES		24.53	32.96	34.52	34.52
MM		623.13	837.29	876.69	876.69
AC-FT		3531.	4744.	4968.	4968.
THOUS CU M		4355.	5852.	6128.	6128.

HYDROGRAPH AT STA O-INL FOR PLAN 1, RTIO 1

1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS: RATIO 1 .50	RATIO 2 1.00
HYDROGRAPH AT	O-EN1	2.70	1	6037.	12079.
		(6.99)	(	170.96)(	341.93)(
ROUTED TO	DAM	2.70	1	11639.	11155.
		(6.99)	(	329.59)(	315.87)(
HYDROGRAPH AT	O-EN2	.50	1	1917.	3834.
		(1.29)	(	54.29)(	108.57)(
2 COMBINED	O-EN2	3.20	1	12412.	12344.
		(8.29)	(	351.47)(	349.54)(
ROUTED TO	DAM2	3.20	1	11144.	12004.
		(8.29)	(	315.56)(	339.92)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	827.30	827.30	831.80
STORAGE	477.	477.	1038.
OUTFLOW	0.	0.	1022.

Eaton

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	832.49	.69	1180.	11639.	1.31	40.83	39.83
1.00	832.22	.42	1125.	11155.	1.15	38.67	37.67

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	785.00	785.30	793.10
STORAGE	3.	4.	227.
OUTFLOW	0.	3.	720.

Leadwood

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	797.04	3.94	600.	11144.	8.50	41.33	0.00
1.00	797.17	4.07	614.	12004.	11.17	40.17	0.00

Output Summary
Various PMF Events
Leadwood Tailings Dam
MO30274
B9

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .18	RATIO 2 .19	RATIO 3 .20	RATIO 4 .21
HYDROGRAPH AT	O-EN1	2.70	1	2173.	2294.	2415.	2536.
		6.99)		61.55)(	64.97)(	68.39)(	71.80)(
ROUTED TO	DAM	2.70	1	871.	926.	981.	9991.
		6.99)		24.67)(	26.24)(	27.79)(	282.92)(
HYDROGRAPH AT	O-EN2	.50	1	690.	729.	767.	805.
		1.29)		19.54)(	20.63)(	21.71)(	22.80)(
2 COMBINED	O-EN2	3.20	1	1150.	1203.	1297.	10010.
		8.29)		32.55)(	34.08)(	35.60)(	283.46)(
ROUTED TO	DAM2	3.20	1	719.	766.	824.	7543.
		8.29)		20.35)(	21.70)(	23.32)(	213.58)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	827.30	827.30	831.80
STORAGE	477.	477.	1038.
OUTFLOW	0.	0.	1022.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
Eaton	.18	831.46	0.00	969.	871.	0.00	43.17	0.00
	.19	831.58	0.00	995.	926.	0.00	43.17	0.00
	.20	831.71	0.00	1020.	981.	0.00	43.17	0.00
	.21	831.83	.03	1044.	9991.	.50	43.83	42.83

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	785.00	785.30	793.10
STORAGE	3.	4.	227.
OUTFLOW	0.	3.	720.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
Leadwood	.18	793.09	0.00	226.	719.	0.00	45.67	0.00
	.19	793.31	.21	241.	766.	4.17	45.50	0.00
	.20	793.49	.39	255.	824.	5.17	45.17	0.00
	.21	796.45	3.35	536.	7543.	5.33	44.33	0.00

Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
B10

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  01 APR 80
**********
    1     A1     EATON MINE DAM, NO. 31163, ST. FRANCOIS COUNTY, MISSOURI.
    2     A2     WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224.
    3     A3     PROBABILISTIC FLOOD - 100 YEAR.
    4     B   200    0    10    0    0    0    0    0    0    0
    5     B1    3
    6     K     0   0-IN1                                  1
    7     K1  RAIN STA--10-LESTRVL -- FREQ= 1.0: -- INTERVAL=  10MIN -- DURATION=  48HR
    8     M     0     2    2.70                 1.0
    9     B   200  8.881                DA =   1.50
   10     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   11     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   12     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   13     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   14     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   15     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   16     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   17     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   18     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   19     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   20     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   21     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   22     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   23     B1  .010  .010  .010  .010  .010  .010  .010  .010  .010  .010
   24     B1  .010  .010  .010  .010  .014  .014  .014  .014  .014  .014
   25     B1  .014  .014  .014  .014  .014  .014  .014  .014  .014  .014
   26     B1  .014  .014  .014  .014  .014  .014  .014  .014  .014  .014
   27     B1  .014  .014  .014  .014  .014  .014  .014  .014  .014  .014
   28     B1  .028  .028  .028  .028  .028  .028  .028  .028  .028  .028
   29     B1  .028  .028  .028  .028  .028  .028  .028  .028  .028  .028
   30     B1  .028  .028  .028  .028  .028  .028  .028  .028  .028  .028
   31     B1  .028  .028  .028  .028  .028  .028  .050  .050  .050  .050
   32     B1  .050  .050  .050  .050  .050  .067  .067  .067  .117  .118
   33     B1  .118  .280  .282  .645  1.357  .529  .281  .118  .118  .117
   34     B1  .067  .067  .067  .050  .050  .050  .050  .050  .050  .050
   35     B1  .050  .050  .014  .014  .014  .014  .014  .014  .014  .014
   36     B1  .014  .014  .014  .014  .014  .014  .014  .014  .014  .014
   37     B1  .014  .014  .014  .014  .014  .014  .014  .014  .014  .014
   38     B1  .014  .014  .014  .014  .014  .014  .014  .014
   39     T                                          -1   -75          0.10
   40     M2          1.34
   41     K    -1    -.05     5
   42     K     1     DAM                                  1
   43     K1      FLOOD ROUTING AND OVERTOPPING ANALYSES
   44     V                          1
   45     V1    1                                  -827.3    -1
   46     V4 827.3  827.8  828.3  828.7  829.3  830.4  831.3  832.2  832.7  833.5
   47     V4 834.2  835.3  836.3
   48     V5   0.    10.    50.   100.   200.   500.   800.  1200.  1500.  2000.
   49     V5 2500.  3500.  4500.
   50     S5   0.     5.    30.    89.   190.   331.   410.   455.   672.  2708.
```

Input Data
1% Probability Event
Leadwood Tailings Dam
MO 30274
B11

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SE  770.   780.   790.   800.   810.   820.   825.   827.   830.   840.
SS 827.3
SD 831.8    2.7    1.5
SL    0.   175.   400.   425.   445.
SV 831.8   833.   834.   835.   836.
SR -10.0    0.5   803.    1.0  827.3  831.8
K    0   Q-INZ                                  1
KI RAIN STA. 18=LESTERVILLE, FREQ=  1.0, INTERVAL= 10. MIN., DURATION= 48 HRS.
M    0     2   0.50                      1.0
Q   -288  8.881                DA =   1.90
T                                          -1    -75          0.20
W2         0.44
X   -1    -.05      5
K    2   Q-INZ
K    1   DAM2                                  1
KI  LEADWOOD MINE TAILINGS DAM FLOOD ROUTING, 100-YR.
V                          1
V1    1                                  -785.0    -1
V4  785.   785.4   785.8   786.6   787.5   788.1    789.   790.   791.   792.
V4  793.   794.   795.   796.   797.   798.   799.
V5    0.    4.5   13.4   37.5   73.6   112.   190.   305.   470.   590.
V5  700.   900.   930.   965.   990.  1020.  1045.
SA    0.    5.   30.   100.   125.   145.
SE  783.   785.3   790.   795.   800.   810.
SS 785.3
SD 793.1    2.8    1.5
SL    0.    90.   255.   325.   370.   615.   960.  1060.  1290.  1800.
SV 793.1   793.5   794.   794.5   794.9   795.5   796.   797.   798.   800.
K   99
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Input Data
1% Probability Event
Leadwood Tailings Dam
MO 30274
B12

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*****************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION   01 APR 80
*****************************************

RUN  DATE* 81/03/18.
     TIME* 05.57.32.

                    EATON MINE DAM, NO. 31163, ST. FRANCOIS COUNTY, MISSOURI.
                    WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224.
                    PROBABILISTIC FLOOD - 100 YEAR.

                                      JOB SPECIFICATION
        NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
       288        0       10        0        0        0        0        0        0        0
                                 JOPER      NWT    LROPT    TRACE
                                     3        0        0        0

    **********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION

        RAIN STA--10=LESTRVL -- FREQ= 1.0: -- INTERVAL=  10MIN -- DURATION=  48HR

                    ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                    O-IN1        0        0        0        0        0        1        0        0

                                     HYDROGRAPH DATA
        IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
            0        2     2.70     0.00     2.70     1.00    0.000        0        0        0

                                       PRECIP DATA
                                 NP    STORM      DAJ      DAK
                                288     8.88     0.00     0.00
                                      PRECIP PATTERN
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .01      .01      .01      .01      .01      .01      .01      .01      .01      .01
      .03      .03      .03      .03      .03      .03      .03      .03      .03      .03
      .03      .03      .03      .03      .03      .03      .03      .03      .03      .03
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Output Summary
Various PMF Events
Leadwood Tailings Dam
MO 30274
B13

.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.05	.05	.05	.05
.05	.05	.05	.05	.05	.07	.07	.07	.12	.12
.12	.28	.28	.65	1.36	.53	.28	.12	.12	.12
.07	.07	.07	.05	.05	.05	.05	.05	.05	.05
.05	.05	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-75.00	0.00	.10

CURVE NO = -75.00 WETNESS = -1.00 EFFECT CN = 75.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 1.34

RECESSION DATA

STRTQ= -1.00 QRCSN= -.05 RTIOR= 5.00

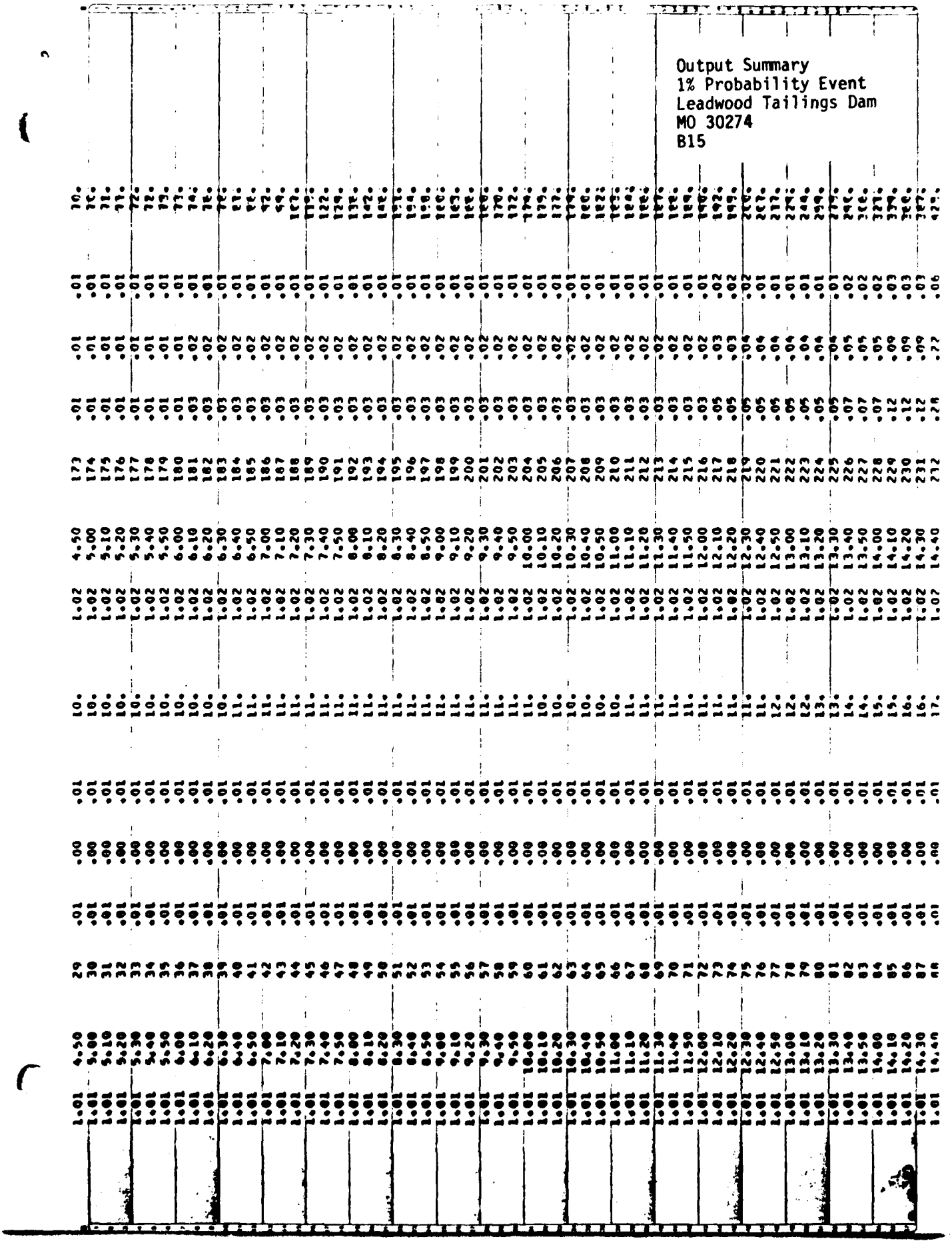
UNIT HYDROGRAPH 42 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.34 VOL= 1.00

38.	120.	230.	384.	579.	753.	862.	910.	910.	867.
795.	709.	598.	477.	385.	317.	261.	220.	183.	151.
124.	102.	85.	69.	58.	47.	39.	33.	27.	22.
18.	15.	13.	10.	9.	8.	6.	5.	4.	3.
2.	1.								

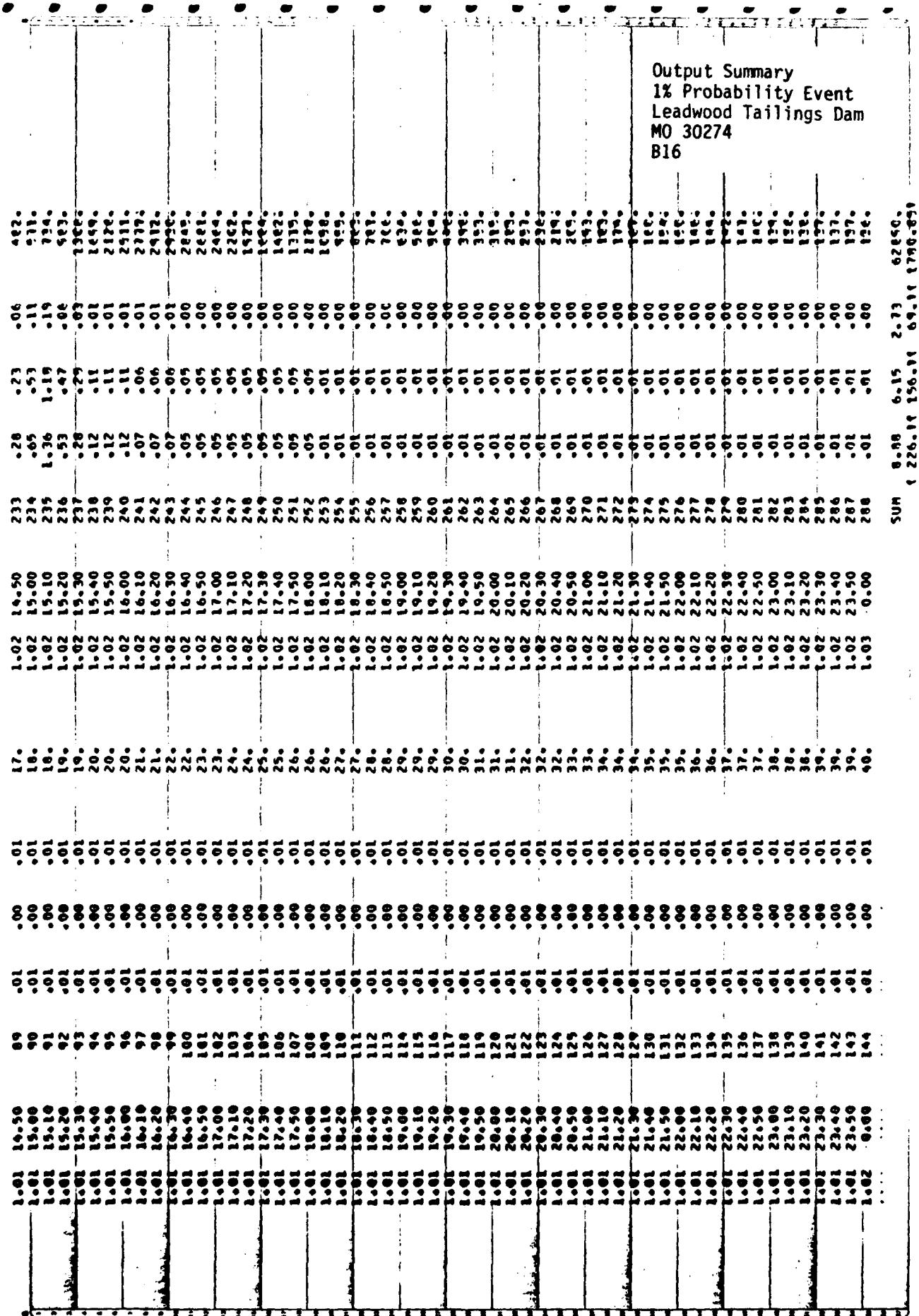
END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.01	.00	.01	2.	1.02	.10	145	.01	.01	.01	[illegible]
1.01	.20	2	.01	.00	.01	2.	1.02	.20	146	.01	.01	.01	[illegible]
1.01	.30	3	.01	.00	.01	2.	1.02	.30	147	.01	.01	.01	[illegible]
1.01	.40	4	.01	.00	.01	2.	1.02	.40	148	.01	.01	.01	[illegible]
1.01	.50	5	.01	.00	.01	3.	1.02	.50	149	.01	.01	.01	[illegible]
1.01	1.00	6	.01	.00	.01	3.	1.02	1.00	150	.01	.01	.01	[illegible]
1.01	1.10	7	.01	.00	.01	4.	1.02	1.10	151	.01	.01	.01	[illegible]
1.01	1.20	8	.01	.00	.01	5.	1.02	1.20	152	.01	.01	.01	[illegible]
1.01	1.30	9	.01	.00	.01	5.	1.02	1.30	153	.01	.01	.01	[illegible]
1.01	1.40	10	.01	.00	.01	6.	1.02	1.40	154	.01	.01	.01	[illegible]
1.01	1.50	11	.01	.00	.01	7.	1.02	1.50	155	.01	.01	.01	[illegible]
1.01	2.00	12	.01	.00	.01	8.	1.02	2.00	156	.01	.01	.01	[illegible]
1.01	2.10	13	.01	.00	.01	8.	1.02	2.10	157	.01	.01	.01	[illegible]
1.01	2.20	14	.01	.00	.01	9.	1.02	2.20	158	.01	.01	.01	[illegible]
1.01	2.30	15	.01	.00	.01	9.	1.02	2.30	159	.01	.01	.01	[illegible]
1.01	2.40	16	.01	.00	.01	9.	1.02	2.40	160	.01	.01	.01	[illegible]
1.01	2.50	17	.01	.00	.01	9.	1.02	2.50	161	.01	.01	.01	[illegible]
1.01	3.00	18	.01	.00	.01	10.	1.02	3.00	162	.01	.01	.01	[illegible]
1.01	3.10	19	.01	.00	.01	10.	1.02	3.10	163	.01	.01	.01	[illegible]
1.01	3.20	20	.01	.00	.01	10.	1.02	3.20	164	.01	.01	.01	[illegible]
1.01	3.30	21	.01	.00	.01	10.	1.02	3.30	165	.01	.01	.01	[illegible]
1.01	3.40	22	.01	.00	.01	10.	1.02	3.40	166	.01	.01	.01	[illegible]
1.01	3.50	23	.01	.00	.01	10.	1.02	3.50	167	.01	.01	.01	[illegible]
1.01	4.00	24	.01	.00	.01	10.	1.02	4.00	168	.01	.01	.01	[illegible]
1.01	4.10	25	.01	.00	.01	10.	1.02	4.10	169	.01	.01	.01	[illegible]
1.01	4.20	26	.01	.00	.01	10.	1.02	4.20	170	.01	.01	.01	[illegible]
1.01	4.30	27	.01	.00	.01	10.	1.02	4.30	171	.01	.01	.01	[illegible]
1.01	4.40	28	.01	.00	.01	10.	1.02	4.40	172	.01	.01	.01	[illegible]

Output Summary
1% Probability Event
Leadwood Tailings Dam
MO 30274
B14


Output Summary
1% Probability Event
Leadwood Tailings Dam
MO 30274
B15

Output Summary
1% Probability Event
Leadwood Tailings Dam
MO 30274
B16



RUNOFF SUMMARY. AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	O-IN1	2930.	1279.	419.	218.	2.70
		82.97)	36.11)	11.86)	6.18)	6.99)
ROUTED TO	DAM	874.	768.	284.	143.	2.70
		24.76)	21.74)	8.03)	4.05)	6.99)
HYDROGRAPH AT	O-IN2	1072.	247.	81.	43.	.90
		30.36)	6.99)	2.29)	1.22)	1.29)
2-COMBINED	O-IN2	1355.	910.	364.	186.	3.20
		38.38)	25.77)	10.32)	5.27)	8.29)
ROUTED TO	DAM2	700.	680.	263.	134.	3.20
		19.81)	19.26)	7.45)	3.81)	8.29)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	827.30	827.30	831.80
STORAGE	477.	477.	1038.
OUTFLOW	0.	0.	1022.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
Eaton	1.00	831.47	0.00	971.	874.	0.00	42.50	0.00

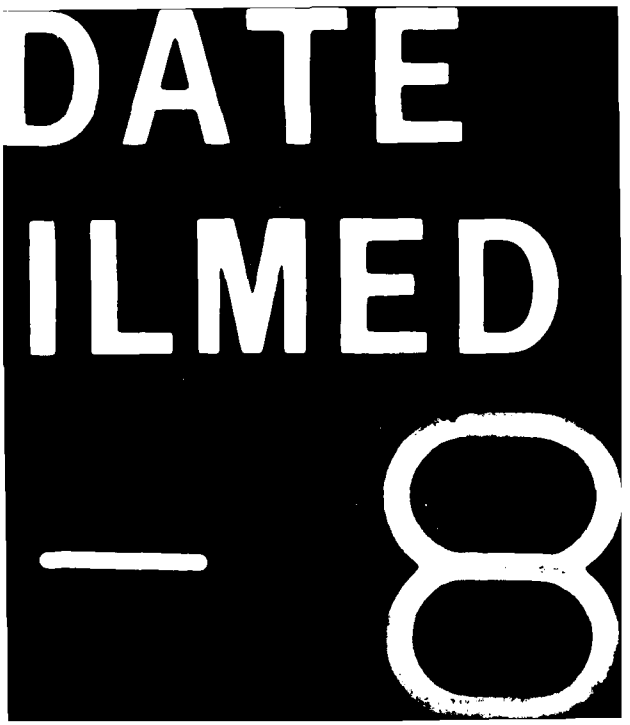
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	785.00	785.30	793.10
STORAGE	3.	4.	227.
OUTFLOW	0.	3.	720.

	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
Leadwood	1.00	793.00	0.00	220.	700.	0.00	45.67	0.00

Output Summary
1% Probability Event
Leadwood Tailings Dam
MO 30274
B17


DATE
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8